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I. DESCRIPTION OF THE GREAT SOUTHERN TELESCOPE.

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SEVERAL years ago the Government of Victoria voted the sum of 5,000*l*. for the construction of a large equatorial telescope to be erected at Melbourne, for the observation of the nebulæ and multiple stars of the Southern Hemisphere.

The construction was entrusted to Mr. Grubb, F.R.S., of Dublin, who stands in the first rank as an optical and telescopic engineer in the manufacture of instruments in which every step is required to be preceded by mathematical research. At the commencement of the present year the telescope was completed and examined by the Committee of the Royal Society who had superintended the work throughout. In a report recently communicated to the Royal Society, the Committee express their unanimous opinion that the equatorial is a masterpiece of engineering.

Before this notice meets the reader's eye, the telescope will probably be on its way to Australia, and as it is beyond comparison the largest and most elaborate equatorial ever constructed, it seems due both to the constructor and to the importance of the instrument that a detailed account of it should appear in the 'Quarterly Journal of Science.' Through the kindness of my friend Mr. Grubb, who has placed at my disposal drawings, photographs, and ample descriptions of all parts of the instrument, I have ventured to undertake this office.

The great Melbourne telescope is of the form known as the Cassegrainian reflector, and is mounted equatorially on what Mr. Grubb calls "the German system improved."

The mirrors, two being supplied in case of accident, are 4 feet in clear aperture, 4½ inches thick, 30 ft. 6 in. in focus, and rest in their box on Mr. Grubb's system of hoops; the whole system of suspension and levers, presently to be described, weighs altogether nearly 2 tons.

Of the tube, 7 feet is made of boiler-plate iron, quarter inch thick, to which is attached by flanges and bolts a skeleton tube, 21 feet long, of steel bars, 3 inches wide at bottom, 1½ at top, and ⅙ of an inch thick, wound spirally round rings of carefully turned angle iron and riveted at the joints, forming a spiral lattice of amazing strength, stiffness, and freedom from tremor. The 7 feet of boiler-plate tube weigh 1,300 lbs., and the 21 feet of the ventilated tube only 1,370 lbs.

At the upper end of the tube, about 25 feet 6 inches from the large mirror, is bolted a very stiff hollow arm of steel-plate, on the extremity of which is a V-shaped gun-metal casting, in which slides an arm carrying the small mirror of 8 inches diameter. This arm is acted upon from behind by a screw, from a pulley on the shaft of which wire-cords are carried over iron guide-wheels down the side of the tube, where they are wound round a wheel to which motion can be given by the observer, for the purpose of focussing.

The polar axis is made up of four distinct parts, *viz.* a cube 3 feet square, to which is bolted on one side a cone 8 feet long which terminates with a bearing 12 inches diameter, resting in a peculiar "plumber-block" on the polar pier, on the opposite side a short toe-piece, which carries on parts prepared for them the two hour circles, sector, and clamp, and terminates in a bearing 6 inches diameter resting in a Y block in the equatorial pier, and on a third side a bell-shaped casting about 2 feet long, which terminates in a slide carrying one bearing of the declination axis, the other being in the side of the cube opposite the bell.

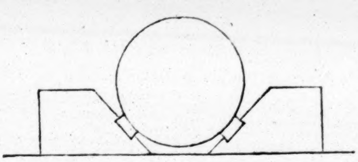
The declination axis is 24 inches diameter at the bearing next the telescope, and 12 inches at the other, the bearings being 5 feet asunder and the axis itself about 9 feet long. It carries at one end the telescope strapped into its cradle, and at the other counterpoise weights, amounting to over 2 tons.

The counterpoise weights are four circular cast-iron boxes, consisting of a ring 10 inches diameter. which is bored out to fit the axis, and an outer ring 30 inches diameter, both 6 inches deep, connected by a plate to form a bottom, and divided into six segments by ribs. These chambers are mostly filled with lead, the outer one being left with a little spare space for adjustments.

The bearings of the polar axis, on the principle of Ys, are constructed with as much delicacy and care as those of a theodolite.

The upper bearing, 12 inches diameter, consists essentially of a large "plumber-block," in which slide, in horizontal grooves, two massive wedge-shaped prisms carrying gun-metal blocks, bearing the axis, and which are acted upon by screws, so that motion can be given to them in a horizontal direction. (See Fig. 1.)

Fig. 1.

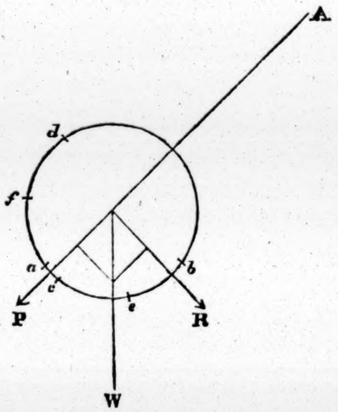


This arrangement is for finally adjusting the axis into parallelism with the pole of the earth. It will be readily seen that by these two screws any required motion can be given: thus forcing both screws in or out equally, will give a vertical motion up or down; while by advancing one screw in proportion as the other is withdrawn, a horizontal motion results in the direction of the retreating screw.

The lower bearing rests in a block of gun-metal bored to fit the axis, and cut away for about 70° at the bottom to give it the property of a Y. The axis terminates in a flat-polished piece of chilled cast-iron, 5 inches diameter, bearing against a flat cushion of bell-metal, which cushion, of a spherical shape on its lower face, rests in a spherical cup. Therefore as the axis is adjusted into its proper direction by the screws in the upper bearing, the motion of the bell-metal cushion in its cup ensures a perfectly even bearing between it and the chilled iron and bell-metal surfaces. Now as the weight of the instrument as it rests on these bearings, of 12 and 6 inches diameter, amounts to about 8 tons, it follows that the friction, if not disposed of in some manner, would be so considerable as to render the instrument quite unmanageable; but in all these bearings there is only about $\frac{1}{50}$th or $\frac{1}{100}$th part of the weight really resting in the bearings themselves, whilst the remainder is supported by apparatus which reduces the friction to a minimum. In this manner are obtained great freedom of motion, less wear, and at the same time all the steadiness of the Y bearing; practically, in fact, more steadiness than if the whole weight were allowed to rest, for then it is found that an inclination exists to *ride up* on the forward side. Accordingly, close above the lower bearing is placed a sector working on a hardened steel pin, and forced up by a screw and strong laminæ of springs on which the axis rolls with a pressure of about 4 tons. Now as the radius of the sector is 27 inches, and the half diameter of the pin is $\frac{7}{16}$ inch, it follows that the friction is reduced in the proportion of $\frac{7}{432}$, or about 62 to 1. The same principle is carried out in the upper bearing, but here the weight not being so excessive, a roller of 8 inches diameter was thought sufficient, acted upon by a lever and weights hanging on the west side of the pier. In addition to this, to take off some of the pressure on the toe-pieces —more to prevent danger of *biting* than for the purpose of reducing friction—the polar axis is laid hold of by a very peculiar steel link chain, so constructed that the links can twist a small quantity on each other without producing friction, which chain is held up by a trussed lever of the proportion of about 8 to 1, acted upon by weights at the back of the pier amounting to about half-a-ton, so as to relieve about 4 tons of end pressure.

So effective is this arrangement, that a force of 5 pounds at a point 20 feet from the centre of motion, is sufficient to move this mass of 8 tons.

FIG. 2.



The arrangement for the relief of the friction in the declination axis is necessarily much less simple. It will readily be seen by an inspection of Fig. 2, which we may suppose to represent the end of the declination axis, and which for simplicity is drawn for a latitude of 45°, P A being the direction of the polar axis, that if we place the axis on Ys at the points say *a* and *b*, when we reverse the instrument to the other side of the meridian these bearing-points will be at respectively *c* and *d*, and the axis would roll out of its bearings; or if we put the Ys at mean points *e* and *f*, all the weight would be on one or other of the Ys, as the instrument is reversed from one side of the meridian to the other, and it would be quite impossible to relieve any portion of the friction by apparatus similar to that used for the polar axis, for what would be right on one side would be quite wrong on the other. Up to the present time this has been the great objection to this form of equatorial; for as explained above, the axis had necessarily to be put into the entire collared bearings without any possible relief of friction, the force necessary to move the telescope, if of any considerable size, became so great as to oblige the constructor to make the bearings of the declination axis very small, and consequently rendered the support of the telescope weak and unsteady. Only in this telescope, and in one other (also constructed by Mr. Grubb) which is now mounted at Dunsink Observatory, near Dublin, the object glass being presented by the late Sir James South to the University of Dublin, has this difficulty, one of the very few objections to this form of equatorial, been overcome.

Referring to Fig. 2, suppose the weight W, acting perpendicularly, to be resolved into two forces, one, P, acting parallel and the other, R, at right angles to the polar axis. The first, P, inasmuch as it is parallel to, and along the axis, is constant in its direction to that axis as it turns round. The second, R, varies in its direction with respect to the axis as it turns, but is constant as regards any vertical line. Now if R could be disposed of, it is evident that the case would be that of an equatorial at the pole of the earth, all the pressure being in a direction parallel to the polar axis. This, then, could be readily relieved by anti-frictional apparatus. To understand how this R is disposed of, refer to Figs. 3, 4, and 5.

Fig. 3.

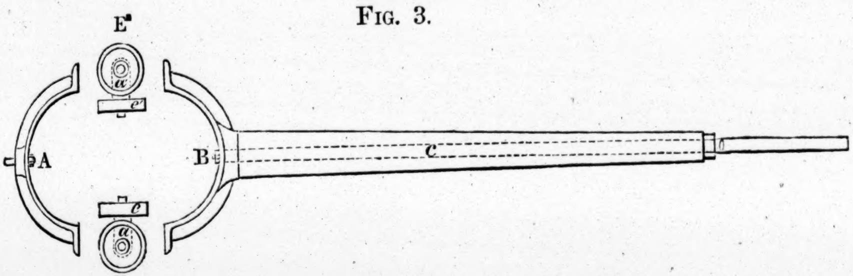


Fig. 4.

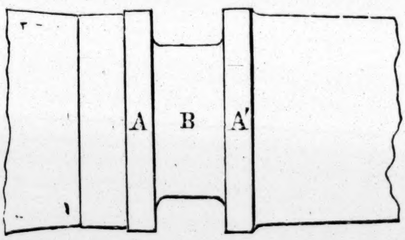


Fig. 5.

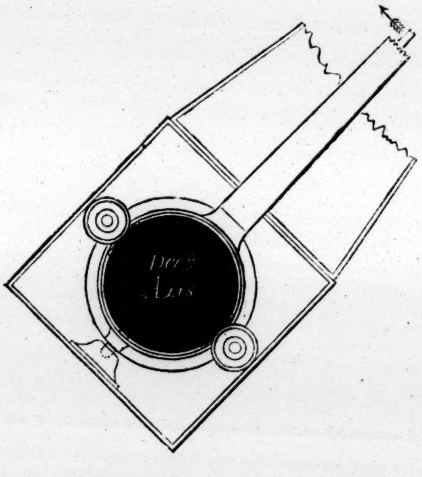


Fig. 3 shows the apparatus, by which this is accomplished, taken asunder. It consists of two nearly semicircular cast-steel rings, A and B, very strong, between the jaws of which, when together, are held the gun-metal carriages, shown at E E', carrying three rollers each, one pair each, *a a'* (one only of each pair can be seen in the figure), and one single, *e e'*, at right angles to the other two. This apparatus when bolted together embraces the declination axis where its axis crosses that of the polar axis (where the declination axis is formed as at Fig. 4). The two pairs of rollers *a a'* (Fig. 3) work on the rings A A' (Fig. 4), whilst the third rollers *e e'* (Fig. 3) work in the groove B (Fig. 4). The lower half-ring has a steel pin *d* (Fig. 3), which rests in a cavity prepared for it at the bottom of the polar axis, where it forms the fulcrum of the lever, while the upper half-ring is prolonged into a stiff trussed bar which runs up through the polar axis and projects at the upper end, where it is acted upon by a sector and lever, which by the application of sufficient weights, which hang down the eastern side of the polar pier, exert a certain force upon it in a direction at right angles to the polar axis. The direction of the force is *independent of, and does not vary with, the turning of the polar axis*, but is constant as respects any vertical line; therefore by applying a sufficient weight to the lever, the whole of the force R (Fig. 2) can be raised on this apparatus and so got rid of. When the instrument is on the meridian, either of the pairs of rollers *a a′* (Fig. 3) is bearing the whole of this R, according to whether it be east or west of the piers: in a position six hours off the meridian the internal rollers *e e′* are bearing all this; while in any intermediate position the weight is divided between *e e′* and either of the pairs *a* or *a′*. It should be remembered that in this instrument the counterpoise of the telescope is hung on the declination axis itself, consequently both the polar and declination axes are balanced *inter se* round their point of intersection, which is very much preferable to the too common mode of hanging the counterpoise to an extension of the polar axis; in which case both axes are out of balance, and this apparatus could not be effectively used.

Having now got rid of the force R, the remainder, P, is easily disposed of. There are two large frames carrying two rollers each, one placed between the large bearing of the polar axis and the cradle, and the other outside the smaller bearing. These are connected by levers running along the side of the cube of the polar axis, where they are centred; and it is so arranged, that by screwing up a nut which connects the levers to the frames, the whole or any portion of the weight of the declination axis can be raised out of its Ys in a direction parallel to the polar axis P (Fig. 2), while the apparatus mentioned above relieves the remainder R (Fig. 2).

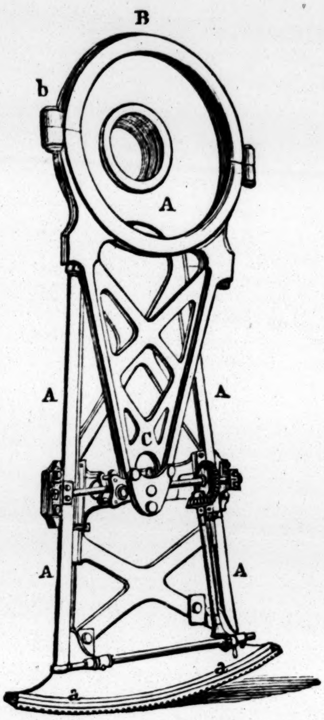
The combination of these systems gives a wonderful ease of motion, combined with perfect steadiness. Fig. 5 shows the apparatus *in situ* in the polar axis.

Hand Motions.—There are four separate gearings for these, *viz.* quick motion in right ascension (AR); slow motion ditto (AR); quick motion in declination (D); and slow motion in declination (D).

Quick Motion AR is obtained by a pinion working into a toothed wheel on the polar axis, immediately below the cube, from which a shaft is brought down, connected by bevel wheels to another running through the equatorial pier, with a wheel at each side, to which motion can be given by a person while watching the AR circles.

Slow Motion AR is obtained by a differential motion between the clock-work sector and AR clamp, see Fig. 6, where A is the sector made up of a cast-iron foundation piece, bored accurately to fit a portion of the polar axis, on which it is strung, but not made fast. From this branch two tubes of steel, trussed with cast-

FIG. 6.



iron lattice, and carrying the toothed sector (*a*) on their extremities. B is the clamp, which is a cast-iron halved ring, which runs on another portion of the polar axis, and to which it can be clamped by half a turn of the screw (*b*). This clamp is connected to the sector by the lattice arm and tangent motion C, of a very peculiar construction.

When the clamp is loose the instrument is quite free of all this apparatus; but the moment the clamp is tightened it becomes a portion of the polar axis; and, as it is connected to the sector by the tangent screw mentioned above, it serves to carry the telescope as the sector is moved by the clock. Again, small wheelwork and shafts being carried to a convenient position low down on the sector from the tangent screw, hook's joint handles can be attached to each side, by which motion can be given by an observer looking into the telescope or finder, whether the clock be in action or not.

Quick motion in declination is obtained by a pinion working into a toothed wheel 4′ 6″ diameter, bolted on the cube of the polar axis, from which a spindle is carried down to the end of the tube, where it is worked by a hand-wheel, accessible to a person looking into the telescope or finder.

Slow motion in declination is obtained by a clamp 4′ 6″ diameter, and tangent screw, somewhat similar to the AR, from which a shaft and hand-wheel is carried to make *it* also accessible to the observer. With such ease are all these motions worked, that two persons at the AR quick motion can reverse the instrument from east to west of its piers in three-quarters of a minute, and that with so little labour as to be compared by some to the working of a table microscope. It will be seen that, with the exception of the quick motion and clamping in AR, all the other operations are brought within reach of the observer himself while looking through either the large telescope or its finder, *viz.* slow motion AR, quick and slow motion declination, clamping declination, and focussing; which last operation is performed by a large hand-wheel, which surrounds the eye-piece, and round a portion of which the wire cords which come from the small mirror are wound.

The support of the specula is one of the most important points in the mounting of the large reflector, and one which, if certain difficulties were not disposed of, would be a complete bar in the way of mounting them equatorially. Two things are essentially necessary.

1st. A system of back supports on which the speculum may lie in a state free from strain of any kind, as if in fact it were floating in mercury.

2nd. A system of lateral support which will preserve the mirror free from strain when turned off the zenith, and will not constrain any slight movement of the speculum.

Now as regards the first condition, nothing could fulfil it better than the system introduced long ago by Mr. Grubb, which was made use of on such a grand scale by the late Lord Rosse as well as by others, and this system therefore with some modification was adopted.

To understand it, suppose the speculum to be divided into forty-eight portions as in Fig. 7, each of them being exactly equal in area and consequently in weight. Now if the centre of gravity of each of these pieces rested on points which would bear up with a force = the weight of each segmental piece, it is evident that there would be no strain in the mass from segment to segment. This is exactly what is accomplished by this system; in fact, if when the speculum is resting on these supports it could be divided up into segments corresponding to those lines they would have no inclination to leave their places, showing a perfect absence of strain across those lines. Suppose now the points representing the centres of gravity of these segments were supported on levers and triangles, so as to couple them together as at A, Fig. 8, and each of these couplings to be supported from a point *a*, representing *the centre of gravity of the sum of the segments supported by that particular couple*, and it is evident that there can be no strain between the components of these couples. Again, let these points *a* be coupled together by the system shown at B, Fig. 8, and their centres of gravity *b* coupled as at C, and it is evident that *the whole weight of the speculum ultimately condensed by this system into these points is supported on forty-eight points of equal support, being the centres of gravity of the forty-eight segments at* Fig. 7. In Fig. 9 is seen the whole system complete. It consists of three screws passing through the back of

Fig. 7.

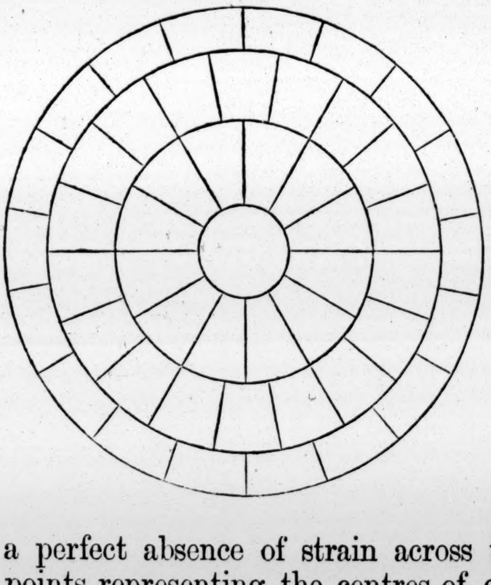


FIG. 8.

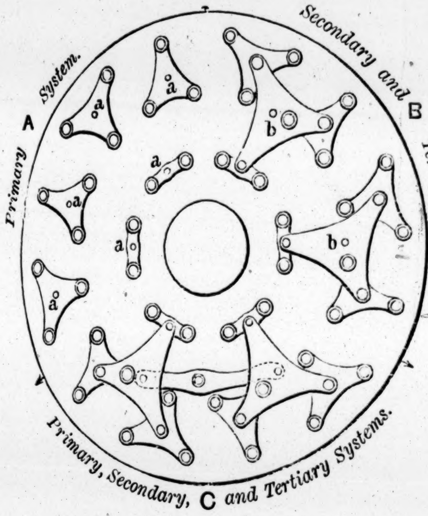
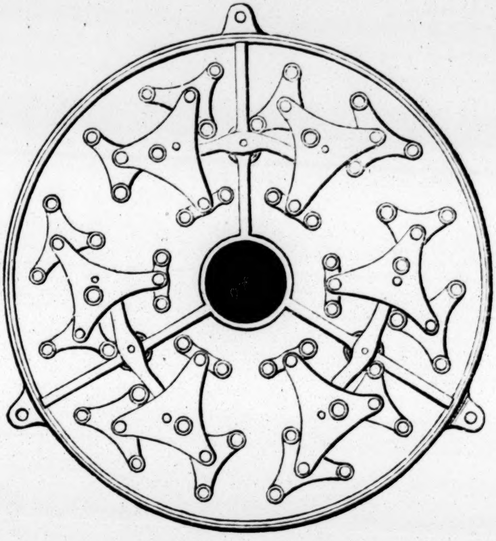


FIG. 9.

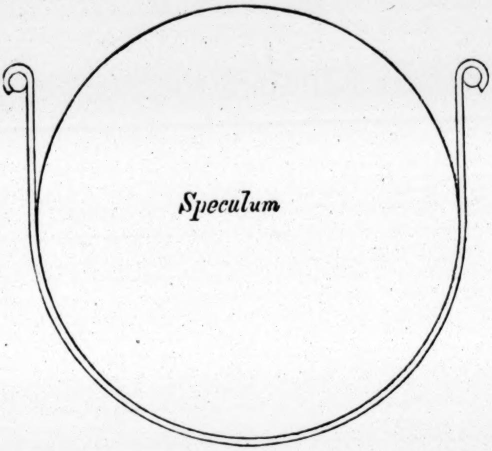


the speculum box (which serve for levelling the mirror), the points of which carry levers (*primary system*) supporting triangles on their extremities (*secondary system*), from the vertices of which are *hung* two triangles and one lever (*tertiary system*). All the joints of this apparatus are capable of a small rocking motion, to enable them to take their position when the speculum is laid upon them. In the system of those levers made by Lord Rosse for his six-feet speculum, the primary, secondary, and tertiary, &c., systems were piled up one over the other, so that the distance from the support of the primary to the back of the speculum was about 15 inches. This, as will be readily seen on consideration, introduced a new strain when the telescope was turned off the zenith, and had to be counterpoised by another very complicated system of levers. But in this telescope, by the substitution of cast-steel for cast-iron, and by *hanging* the tertiary system from the secondary and allowing it (the tertiary) to act in some places through the secondary, the whole system is reduced to 3½ inches in height, and the distance from the support of the primary lever to the back of the speculum is only 1¾ inch, by which means this cumbersome apparatus is entirely done away with.

The ultimate points of the tertiary system are gun-metal cups which hold truly ground cast-iron balls with a little *play*, and when the speculum is laid on these it can be moved about a small quantity by a person's finger with such ease as to seem to be floating in some liquid.

The System of Lateral Supports was devised by Mr. Grubb specially for this instrument. One objection originally raised to the mounting of these large telescopes (reflectors) equatorially, was that such heavy mirrors could only be supported *laterally* in a

FIG. 10.



flexible hoop, as in Fig. 10, to preserve them from strain, and consequently it was impossible to mount them equatorially, when they would sometimes be turned upside down and would roll out of their hoop. Mr. Lassel ingeniously got over this difficulty by making his telescope revolve in its cradle so that he could always keep one diameter vertical; but this plan, apart from its inconvenience and clumsiness, destroys all accuracy of adjustment.

Mr. Grubb's system will be best understood by reference to Figs. 11 and 12. Both these figures are sections of the speculum and its box, Fig. 12 being enlarged to show better the rings of support. C is a portion of the speculum-box, to which is attached on the inside a wrought-iron ring of the section shown at A; this may be considered inflexible from its construction. On this ring hangs another, B, another portion of which embraces the speculum round a part that was carefully turned by revolving grinders. Now this ring B may be considered as *the indispensable flexible*

FIG. 11.

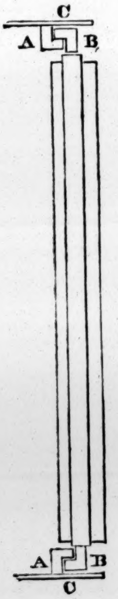
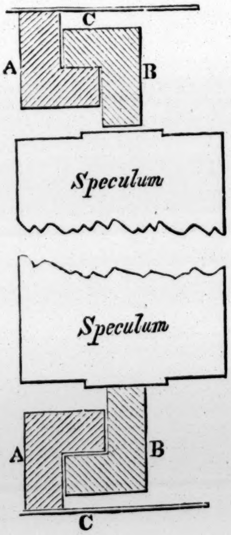


FIG. 12.



hoop hanging from A, and on which the speculum is hanging, but with this peculiarity that it is equally effective in all positions; and again at the upper side the speculum is free from the ring B, while at the lower side the ring B is free from A. Therefore the speculum is not confined in any exact position or prevented from taking a proper bearing on its back supports. This is just what is required, and so effective is this apparatus that on no occasion could any evidence of strain be detected by the most critical observer.

The driving clock is, as may be readily supposed, of rather ponderous dimensions, but is still, considering the size of the telescope it has to move, as compact as possible, fitting in a niche 2 feet square and 3 feet high. Its regulating power is that of a governor, the balls of which, when the desired speed is attained, fly out and bring two leather pointed screws into contact with a circular disc, which serves by the friction thus produced to prevent any acceleration of rate. Several driving clocks have been constructed on this principle, but owing to the omission of some very important details, nearly if not all of them have proved quite insufficient for their work, and consequently clocks of this kind are looked upon by many with distrust and incredulity of their efficiency, but it has been found that when this clock is constructed with proper attention to its details it presents some very important advantages for driving large equatorials. No clock is able to produce any correction in speed until *after* an error has been committed. Consequently the question becomes, What clock is it that corrects these errors most efficiently and most instantaneously? That this clock corrects errors in speed efficiently is proved by the fact that doubling the driving-weight (*viz.* that weight which will just keep the friction screw in contact) produces an acceleration in speed of only $\frac{1}{360}$ part, whilst the great *vis inertia* of the balls themselves (weighing about 20 lbs. each) prevents any sudden oscillation, so to speak, in rate; and that this regulating action takes place more instantaneously than in other clocks may be readily understood by inspection of the construction, when it will be seen that the actual movement required in any of the members of the governor to correct an excessive difference of power like the above amounts to something probably under $\frac{1}{1000}$ inch, instead of having to move by some considerable quantity a complicated system of link-work connected with fans, breaks, water regulators, air regulators, &c., &c., whose name is legion, and whose principal effect is that if one of them gets out of order all the rest are powerless. The general effect of these complicated systems is that when any error is made the ensuing correction is too great, which necessitates a counter-correction in an opposite direction, and so an oscillating effect is produced, which gradually subsides until matters again attain their equilibrium. An experiment has been tried with this clock which will form a record of its work and a comparison for other clocks. The clock was used to give motion to a long ribbon of paper on which lines were traced by a pencil worked by a free pendulum in a direction at right angles to the motion of the paper itself. The result was of course a wave line, the length of each wave being a measure of the second as given by the clock. During the process at certain points the driving weight was increased from $1\frac{1}{2}$ cwt. to 2, $2\frac{1}{2}$ and 3 cwt., but the difference of rate is insensible on the diagram, although capable of being measured to the $\frac{1}{100}$th of a second. If this experiment were tried with other clocks it would form a valuable record of their work, independent of the testimony of their constructor. The shaft which is carried from the clock to drive the telescope is severed in one place and a system of six differential wheels introduced by which the rate can be rapidly altered $\frac{1}{20}$th part, this being the mean of the extreme differences between siderial and lunar rate, whilst a small lever and graduated arc, in front of the clock acts on the governor spindle, moving it up or down, and by this means altering the working angle of the balls, to make the final correction per lunar rate *pro tem.* Both of these adjustments can be made while the clock is in action.

It is difficult to understand how in this system of clockwork a great increase of power (2 to 1) can produce such a small difference of rate ($\frac{1}{300}$), and how the great overplus of power is used up by the small increase of velocity. The principle will, however, be understood by the following:—Suppose the arms of the governor are working at an angle of 45°, and the pressure on the friction-wheels to be applied at the same radius as the circle described by the centres of gravity of the balls. Then $c^\circ = \zeta$, where c° is the centrifugal force which will just keep the balls at this angle. Let p°, p, and p' be the pressures on the friction-screws corresponding to the velocities v°, v, and v'; the centrifugal forces c°, c, c' will evidently be as $v^{\circ 2} : v^2 : v'^2$, while the corresponding pressures will be as $c^\circ - \zeta : c - \zeta : c' - \zeta$, or as $v^{\circ 2} - \zeta : v^2 - \zeta : v'^2 - \zeta$. Now if $c^\circ = \zeta$, the first pressure $= 0$, whilst if c and c' be very small increments on c°, p' will bear a very large proportion to p. Suppose, for instance, the velocities to be as 100 : 101 : 102, the centrifugal force will be as 10,000 : 10,201 : 10,402, and the pressure will be as 0 : 201 : 402, so for an increase of 1 per cent. in velocity, we obtain double the retarding force in this particular instance.

The hour circles are 34 inches diameter, and covered with a band of an alloy of silver and palladium, they are divided to minutes of time, and read to seconds by the nonius, the differential reading always giving actual Æ.

The declination circle is 30 inches diameter, covered with the same alloy; it is divided to 10′ of arc, and reads to 10″ of arc.

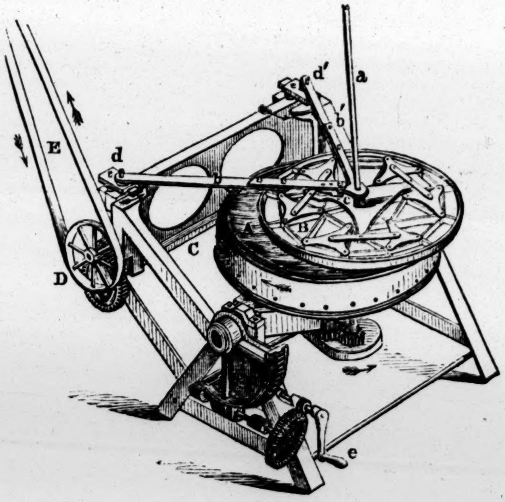
The preparation of the specula was carried on at the same time and in the same premises in buildings specially constructed, wherein the mounting was both manufactured and erected.

The alloy used was rather higher than what has hitherto been used for such large mirrors. The proportion was copper 32, tin 14·77. The mirrors were cast on Lord Rosse's "Bed of hoops," but with several very important modifications of his process.

The annealing was conducted in a circular oven and took twenty-three days. Immediately on being removed from the oven, the specula were placed on the machine, and rough-ground on front, back, and edge, during which process they rested on several thicknesses of cloth; from this they were removed to their own boxes, where they rested on the system of levers before described. The finer grinding and polishing was then proceeded with, and the specula were never after raised from their supports.

The Grinding and Polishing Machine, as devised by Mr. Grubb, is shown in isometric perspective in Fig. 13, where A is the speculum in its box, revolving on a vertical spindle, which, by a peculiar mechanical contrivance, is made to work with great ease and steadiness. B is the grinder strongly ribbed at back, and supported from its strongest points by six triangles of wrought iron. Three coupling levers unite these, which are in their turn supported by a strong central tripod. In a hole in the centre of this tripod is inserted a collared cylinder, so formed as to allow of a rocking motion through this cylindrical piece, and attached to it by a cross key, passes the bar *a*, which is supported at its upper end by a lever and weights (not shown in drawing) to balance a portion of the weight of the grinder. This vertical bar is laid hold of by the double bar *b b′* linked at *c*, and to which motion is given by the cranks *d d′*. These cranks receive their motion from the main shaft C, which is worked by the wheel pinion and pulley D, driven by the belt E. By the adjustment of the lengths of the cranks *d d′* of the beam *b b′*, and the relative velocities of the crank, shafts, and

Fig. 13.



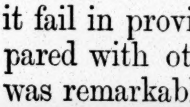
speculum, all the curves given by Lord Rosse's machine, and any of those given by other machines which have been found practically useful, are obtained. Some consider that the motion of the grinder or polisher should be itself controlled and capable of being regulated at pleasure, but it has been found that the free motion of the polisher forms a most accurate criterion of the action, *pro tem.* If that action be good, the polisher revolves just as it is desirable; but if anything occurs to disturb that good action, immediately it commences to revolve fitfully, either too quickly or too slowly, and thus gives notice of something requiring attention.

For the purpose of trial, as it would have been very troublesome to be obliged to remove the speculum to the telescope on every occasion of trial, the machine is so constructed that by turning a handle (*e*), the whole frame carrying the speculum is tilted into a vertical position by the endless screw and worm *f*, and a dial-plate and artificial star being placed at 800 feet distance, the mirror, used as a front-view telescope, is ready for trial in five minutes, which saves some two days' work on every occasion, besides avoiding risk. So efficiently and with such certainty did this machine do its work, that on no occasion, having once ascertained what was required, did it fail in providing the requisite alteration of figure, while as compared with other machines the ease and steadiness of its working was remarkable.

The photographic apparatus embraces every improvement proposed by Mr. W. De la Rue, and more especially those suggested by some experiments made with a rough trial apparatus fitted to the great telescope, with which photographs of the moon have been taken, exceeding in beauty and sharpness any hitherto accomplished in this or any other country.

The spectroscope has been made with a totally different style of mounting to those in general use, with a view of making it a more practically useful tool, whilst the prisms which are adapted to it are made of one very dense flint of about 90° or 100°, with prisms of light crown cemented on each side of angles of about 20° to 25°, Fig. 14; this gives a very large amount of dispersion with very little deviation, whilst the crown prisms protect the surfaces of the flint from tarnish, which has proved such a drawback to the use of heavy flint, for although it can be removed by friction and nitric acid, yet every time this operation is resorted to it leads to a depreciation of surface.

FIG. 14.



The contract signed in the beginning of the year 1866, included all the above-mentioned parts, with the exception of the photographic apparatus and the spectroscope, and amounted to 4,660*l.*; the instrument to be completed in twenty months, and although that time was slightly exceeded, yet, as stated by the committee, the delay arose solely from the state of the weather precluding all observation for trial of the specula.

In their report on this magnificent instrument, presented to the Royal Society in April last, the committee pay a well-earned compliment to Mr. Grubb. After minutely examining and testing it, they express their admiration of the perfection of the telescope, and of the mechanical contrivances for its adjustment; and they add that, considering the contract price and that special works had to be erected for the purpose of constructing the instrument, they are convinced that Mr. Grubb has been influenced much more by the desire of producing a scientific masterpiece than by any prospect of pecuniary advantage.

II. ON THE POST-TERTIARY BEDS OF NORWAY AND SCOTLAND.

By Rev. Henry W. Crosskey, F.G.S.

Many of the grave difficulties attending the study of the glacial epoch result from two causes: (1) the want of discrimination between different members of a whole series of deposits; and (2) the looseness of the nomenclature employed. By the "Glacial Epoch" we understand that period intervening between the commencement and cessation of more rigorous conditions of climate than are now prevalent south of the Arctic Circle, and during which a large and varied series of clays, sands, and gravels, frequently fossiliferous, were accumulated and deposited through the northern districts of both hemispheres. These deposits, however, have been confusedly heaped together under various general names, and little distinction has been drawn between their upper and lower members, while the same terms have seldom been used in precisely the same sense by investigators at separate localities. It may, *e.g.*, be said that certain shells occur in the "Boulder Clay," and this may mean that they are found fossil, either in the higher or lower bed of a series, the members of which were deposited under considerable varieties of climate, and have had their position determined by different oscillations of the earth's crust.

The only method of obtaining a clear and comprehensive classification of these deposits of the glacial epoch, and solving the great problems involved in those recent changes in physical geography with which they are connected, is by instituting a careful comparison between their developments in various countries. Scotland, Canada, Sweden, and Norway furnish beds containing a large series of well-preserved fossils, and when their relationships are fairly determined the key to many larger questions will be discovered.

In order to commence one portion of the many investigations required, the writer, in company with a well-known Scotch naturalist (Mr. David Robertson), visited many of the Post-tertiary beds on the West of Norway, and in the present paper will endeavour to record a few results of the observations made.

I. The first great series of shell-beds indicates the extremest degree of cold (as far as this can be indicated by any fauna) attained during the glacial epoch.

These oldest Arctic shell-beds furnish a clear and definite starting point for our inquiries, and their analogies in Scotland and Norway, both in position and general character, are curious and instructive.

The position of the shell-beds indicates the existence of glacial conditions previous to their deposition, together with the gradual submergence of the ice-clad land. In the west of Scotland the shell-bed rests upon a hard and compact clay, containing striated stones and travelled boulders, but devoid of fossils. The boulders and stones are in the larger proportion from neighbouring hills, a certain number however being always traceable to more distant heights. The force by which this clay was accumulated acted under local conditions, but extended from afar. The striæ upon the underlying rock, and even upon enclosed fragments of shale, are so delicate that they indicate considerable slowness and gentleness of motion in the formative power, while the compactness of the mass indicates long-continued pressure, and not the drifting action of a storm. In one remarkable instance in Ayrshire a face of encrinal limestone has been exposed exquisitely polished. It rests beneath a mass of the clay now described and sections of encrinite are displayed in every position as perfectly as in any marble mantel-piece from Derbyshire. It may be noticed that in hollows the polishing process has been only half complete, but even when half complete it is almost more delicately worked than would be possible by the hand of man.

The shell-beds of the west of Scotland rest in hollows washed out from this boulder clay, so that a long period of ice action preceded the existence of the Arctic Fauna. There is evidence of the same fact in Norway. Resting upon the grooved and polished rocks at various points throughout the country, and reaching elevated positions on the mountain slopes, is a boulder clay which is precisely similar (local circumstances being taken into account) to that so well known to Scotch geologists. This is older than the shell-clay. It contains no record of a fauna, and was probably produced by the action of land ice. A comparison between the two countries thus gives a well-marked period for further study, *viz.* the history of the period between the commencement of the severe climate and the deposition of the shell-clays.

Another period also may be noted, between the beginning of life within the waters and the point of its extremest abundance. In such localities as the Upper and Lower Foss near Christiania, the lower part of the shell clay is very finely laminated, and contains comparatively few fossils.

The fine laminations of the lower clay, also, are characteristic of the beds at Paisley and throughout the whole Firth of Clyde,—beds equally deficient in fossils. A few foraminifera of the hardiest types are the only animals which have yet been detected in the laminated mud of the Clyde district. The flowing of mud-laden waters from inland ice would produce precisely such a mud as that we have observed beneath the more abundantly fossiliferous clays of Norway and Scotland. The highly comminuted particles deposited in layers would cause the laminations, while the coldness of the waters would limit the development of animal life.

A period of most abundant arctic life succeeded that of which we have in the laminated mud so imperfect a record. We have a deep sea instead of the estuaries into which the cold waters of great rivers were poured. The profuseness of molluscan life at this period, both in Norway and Scotland, is most remarkable. The beds of Pecten Islandicus, *e. g.*, extend along the Firth of Clyde at intervals for many miles. The shells in the clay-pits at Paisley interfere with the working of the clay. Exactly as at the present day, molluscan life is abundant at the edges of the glaciers as they overhang into the sea, so it must have been during this part of the glacial epoch. Another arctic characteristic is the connection of this abundance of life with the extensive development of a few species, rather than the distribution of the fauna into many genera.

The shell-beds of Scotland indicate a degree of cold almost as great as that manifested by the most arctic shell-clays of Norway.

There is a remarkable correspondence between a clay at Moss on the south of the Christiania fjord and a clay at Errol in the Carse of Gowrie. The characteristic shell in both clays is Leda arctica. It evidently has not been drifted but occurs *in situ*. Leda arctica is found living on the east coast of North America and within the arctic circle, not in the British seas or North Pacific.

At Moss and Errol, also, we find that the shells with which Leda arctica is associated are precisely the same and equally arctic in their characteristics. Tellina calcarea is large and abundant, while Buccinum Grœnlandicum may also be collected. It is not therefore the question of an isolated species; and the Norwegian and Scotch beds at these localities must be held to represent the same climate, so far as similarity of climate can be represented by correspondence of fauna.

Taking the older arctic shell-clays generally, Sars has described fifty-nine species of mollusca from the Norwegian beds, and of these fifty-nine species forty-eight have been collected in Scotland by Mr. Robertson and the writer. Sars has collected his specimens from Trondhjem to Avemark; we have collected ours from Caithness to Paisley, and are yet only deficient in eleven species, all of which may possibly occur in connection with those already found, since they have at the present day the same habitat in the Northern seas.

The great divisions under which the glacial fossils of Scotland may be classified render this comparison still more striking. The first class includes mollusca, unknown in the British seas, but living in high northern latitudes, such as Astarte borealis, Pecten Grœnlandicus, Tellina calcarea, Velutina undata. The second class comprises northern forms of species yet existing in British seas. Trophon clathratus, *e. g.* attains a large size, while Lacuna divaricata occurs in a variety, which Torell states can be abundantly collected on the coast of Iceland. The third class includes species comparatively rare in British waters, but very abundant in the shell-clays. Panopœa Norvegica, *e. g.*, now only found in deep water on the Dogger Bank, is far from rare as a glacial fossil. The fourth class includes those species which, while found both living and fossil in their ordinary forms, have yet a high range, no shell being found fossil in the older glacial clays which does not also possess an arctic habitat.

Associating together these facts, (1) the precise agreement between the characteristic shells at special localities; (2) the actual occurrence in Scotch beds of a large proportion of the most arctic species of the Norwegian clays; (3) the exhaustive classification which may be made of the glacial fossils of Scotland, showing even the most delicate arctic variation of existing species; we have a close correspondence of conditions now only prevalent in very high latitudes, common to Scotland and Norway during the glacial epoch.

The elevation of the older shell-clays of Norway extends from 10 feet to 450 feet, or 500 feet above the sea-level. Balani have been found attached to the rock in Avemark at a height of 450 feet. The highest shell-bed found in Scotland is 526 feet, near Airdrie, and the beds extend to this height, as in Norway, from points not far above sea-level. The correspondence upon several points of detail connected with this elevation of the earth's crust, is curious. Within a radius of a few miles near Glasgow, shell-beds of the same glacial character crop out at varying heights, from half-tide mark, in the estuary of Clyde, to 10 feet, 40 feet, 150 feet, 526 feet. In the Christiania fjord the same phenomena appear. A clay bed may be found, *e. g.*, 50 feet above the sea, and within a few miles another, belonging to the same age in its fossil contents, at 240 feet.

Whether therefore we investigate the physical position of the older glacial shell-beds of Scotland and Norway, their order and elevation, or their fossil contents, we find that they unfold a series of parallel phenomena, and suggest problems which refer to cosmical causes rather than the accidents of local circumstance.

II. The second great series of beds indicates a change from the extreme arctic conditions of the preceding period. 1. There are sufficient proofs, we believe, that the change of climate did not take place suddenly. The phrase "Raised Beaches" entirely fails to express the varying characteristics of the beds usually comprehended by it. It is necessary to study each deposit by itself, and carefully catalogue the contents, with the proportions in which the species occur; and different zones of marine life will frequently be found comprised under the general term "Raised Beaches."

Many of the Norwegian beds contain a mingling of arctic species with a large development of those, now the common inhabitants of the neighbouring seas.

The first characteristic indeed of these semi-glacial or post-glacial beds, is the very large increase in the number of species contained. Individual specimens may be as abundant in some glacial as in some later deposits, but invariably, species are far fewer in the more arctic clays. We previously quoted the fact, that Sars has collected fifty-nine species of mollusca from the glacial beds; from the succeeding series, he has catalogued 175.

In these deposits also, both individual specimens of arctic species, as well as arctic species themselves, are less predominant. We have reached the period at which arctic forms have not left the waters, but have received a check, and are being driven northward to a more congenial clime. Magnificent examples of this class of beds occur near the small town of Skien, on the northern side of the Christiania fjord.

At the south end of the beautiful lake Nordsaeen is a large shell bank, scattered in massive undulations over many acres. Its elevation is about 100 feet above the sea. It contains 128 species of mollusca, a number in itself far exceeding that contained in the whole of the older glacial clays. Among these 128 species, there are very few that may not be found living in Christiania fjord; but these few are arctic in character. For example, Pecten islandicus is small and rare; Tellina calcarea is large and tolerably abundant; but some characteristic arctic species have disappeared. Leda arctica, and even Astarte borealis are absent; while the relative proportion of the remaining glacial forms has become entirely subordinate.

The same phenomenon is developed in a large series of similar beds, spread over the west of Norway; and appears conclusively to establish the gradual character of the climatic change.

In Scotland, careful study of the clay-pits will, we think, manifest a corresponding fact. On the lower part of the Dalmuir deposit, *e. g.*, is a sandy clay, in which the arctic mollusca are very large and abundant; but in the upper part of the bank, they are neither so large nor plentiful. The general aspect of a collection made from the upper and compared with one from the lower part, of almost any clay bed in the nighbourhood of Paisley, will indicate a striking difference of condition.

At the base, resting either on the boulder clay or the native rock, is the laminated mud, with a few foraminifera, evidently indicating conditions unfavourable to molluscan life. This is followed by a large and fine development of arctic shells, which often are so plentiful as to interfere with the economic working of the clay. These shells, however, gradually become more and more rare. Evidently they have been driven away by the shallowing of the water and other physical alterations. At last, in the uppermost marine clay, scarcely a shell occurs, until in the sands and gravels of the old river bed we have the remains of a fresh-water fauna.

These deposits thus unfold a series of changes from the comparatively deep waters of the glacial sea, to the estuary of the ancient Clyde; and their evidence corresponds with that of the Norwegian beds, in emphasizing the quiet and gradual nature of the successive steps.

The elevation of the land, which took place during this period, has left its record in the existence of fossil beds, both of deep sea and of littoral character. In the island of Barholmen, off Dröbak, a remarkable instance occurs. A fossil bank, reaching from the sea level to the height of 20 or 30 feet, contains a wonderful and peculiar deep-sea fauna. Oculina prolifera is abundant, a coral which, Sars states, is found on the north and west coast of Norway, but never at a less depth than from 150 to 300 fathoms. A clear proof of the elevation of the land to the extent of, at least, 800 feet, is thus obtained. The argument is strengthened by the association with Oculina prolifera of both mollusca, entomostraca, and foraminifera, characteristic of great depths of water. Lima excavata is found, abundant, and of very large size, together with Pecten vitreus and Pecten aratus.

At the summit of this island, a height of about 100 feet, a fossil bank also appears. This contains fragments of Oculina and a few of the shells common in the shore bed, but they are associated with littoral species. Littorina littorea, *e.g.*, is most abundant, and completely characteristic of the deposit.

The upper and the lower banks on Barholmen thus belong to the same age, but the one is littoral in its character, and the other must have been uplifted from beneath a very great depth of water.

In these beds at Barholmen, the peculiar species of the older arctic clays do not occur, and they must be classified in the post-glacial series. An elevation of at least 800 feet therefore has taken place in this district, since the retreat of the arctic mollusca to their present latitude.

There are also signs in Scotland, of elevation of the land since the glacial epoch. The large bed of Ostrea edulis, which extends through the whole plain at Stirling, and is associated with a clay containing several specimens of the whale, is post-glacial, and the shells are undoubtedly *in situ*. In the course of the river Irvine, the following section occurs:—(1) clay, with Cyprina islandica; (2) sand, with remains of whale; (3) purely littoral sand both in aspect and contents, equivalent to that on the present shore. The gradual upheaval of the land in post-glacial times, converting the habitat of Cyprina islandica over which the whale journeyed into the shallow sandy shore which became its tomb, is by this section very closely indicated.

The courses of arctic currents and of currents equivalent to the Gulf-stream, must have been greatly affected by the physical alterations in the relative position of land and water, produced during the history now briefly sketched, and have acted upon the direction of the isothermal lines.

In certain beds, the fauna appear to indicate results of this description. At Bisæt, near Christiania, Isocardia cor, a shell which inhabits the Mediterranean, as well as the southern parts of the Scandinavian waters, is associated with the eminently arctic species Tellina calcarea. A corresponding fact may perhaps be quoted from the Hebrides at the present day, where several especially northern forms reach their most southern limit; and certain peculiar species have no locality recorded between that district and the Mediterranean.* A fossil bed at half-tide mark, in the Kyles of Bute and other localities, differs somewhat in its contents from the present fauna of the district. Pecten maximus and Ostrea edulis are far larger than now found in the Firth, while Psammobia Ferroensis and Tellina incarnata are more abundant than in recent dredgings in the neighbourhood.

Reviewing the various points indicated in the present paper, we arrive at the following suggestions for further investigation:

(1) The course of physical changes from the glacial epoch to the present day, was the same in its broad outlines in Norway and Scotland.

(2) These changes were gradual and have left their evidence in the shell-beds as well as in physical phenomena.

(3) It is necessary, therefore, to separate and classify these various shell-beds and not include them under the general names of "Drift" and "Raised Beach."

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* See Reports by Mr. Gwyn Jeffreys on Dredging among the Hebrides.

(4) A general order of succession and variation in the glacial deposits characteristically prevails both in Scottish and Norwegian localities, and embraces the phenomena of an epoch, rather than the merely subordinate accidents of local circumstance.

III. ON THE IRON-PYRITES MINES OF ANDALUCIA.

By A. H. Green, M.A., F.G.S., of the Geological Survey of England and Wales.

For abundance and variety of mineral products, scarce any land in the world can match Spain; but owing to the state of torpor into which this once active country has fallen, it has become all but a matter of impossibility to work her mines with profit. English and French capital and energy have, however, of late, in many instances, successfully battled with the difficulties of such an undertaking; and among the districts thus opened out is a mineral tract reaching across the western part of Andalucia and the adjoining portion of Portugal, which contains many very large and remarkable deposits of Iron-pyrites.

My own knowledge of this ground was gathered during rather a hasty visit, but I have been able to add to it from the works quoted below:* these, however, are but little known to general readers, and are besides of a somewhat technical character, and I therefore hope that the rather more popular account which I am undertaking may be neither unacceptable nor superfluous.

The rock of the district is clay slate, Silurian in age,† bedded, but not cleaved; talcose and micaceous slates are also met with, and here and there beds of quartzite. The strata rear up at very high angles, and are much contorted; but I was told that a general north-easterly and south-westerly strike could be traced. Over the slate tract are scattered many "masses of porphyry of different kinds, passing here and there into diorites, accompanied at some points by masses of cupriferous iron-pyrites, which at the surface are represented by deposits of oxide of iron, known in the country by the names of *colorados, monteras de hierro*, or *requemones*. The porphyritic masses are as a rule not very large, of small breadth, and

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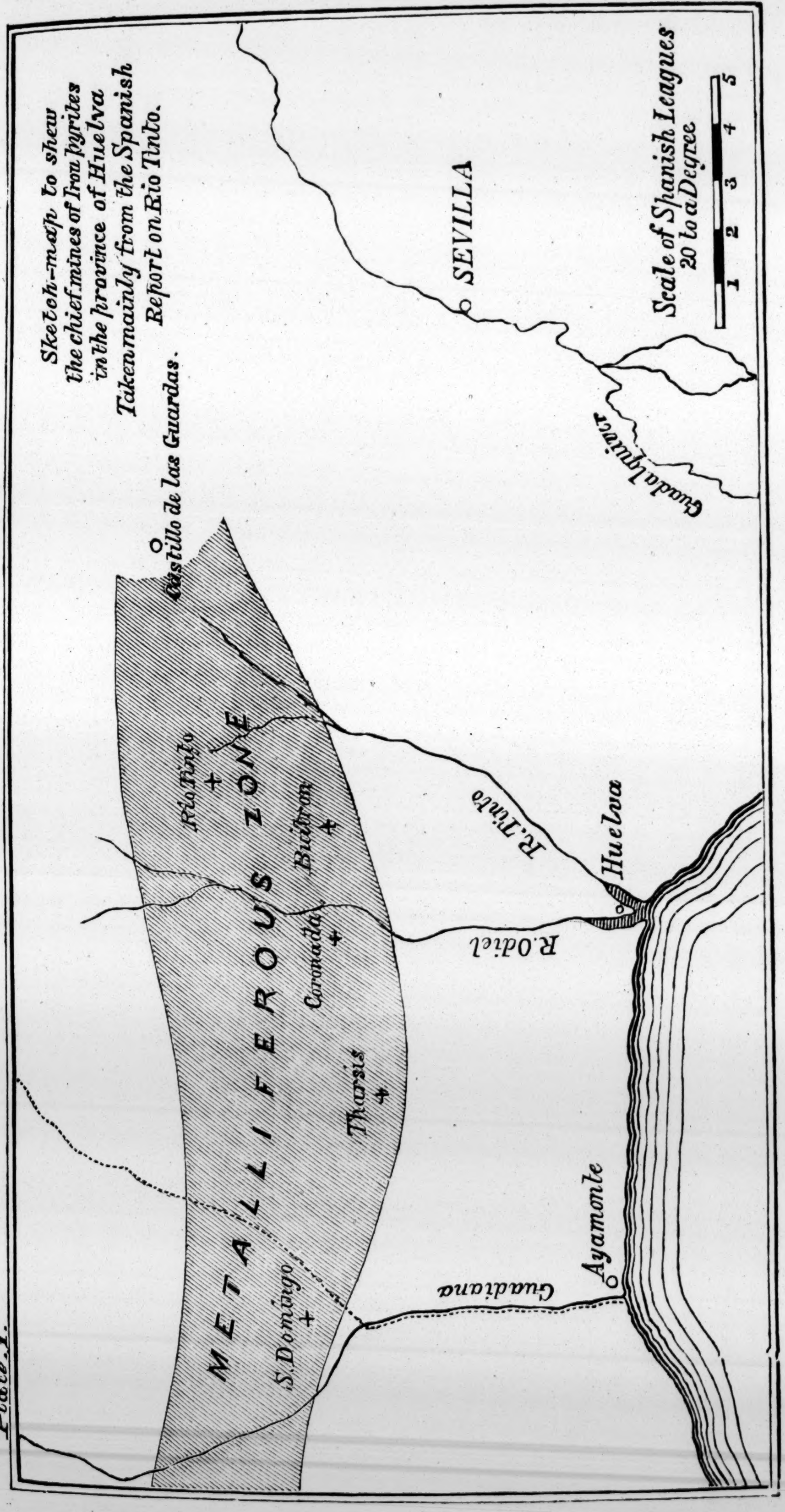
* 'Notes on the Copper Mining Districts of the Provinces of Seville and Huelva.' By James Mason. London. 1858.
'Notes on the Mines of Rio Tinto.' By J. Lee Thomas. London. 1865.
'Memoria sobre las Minas de Rio Tinto:' presentada al Gobierno de S. M. Madrid. 1856.

† 'Carte Géologique de l'Espagne et du Portugal.' M. E. de Verneuil et E. Collomb. Paris. 1864.

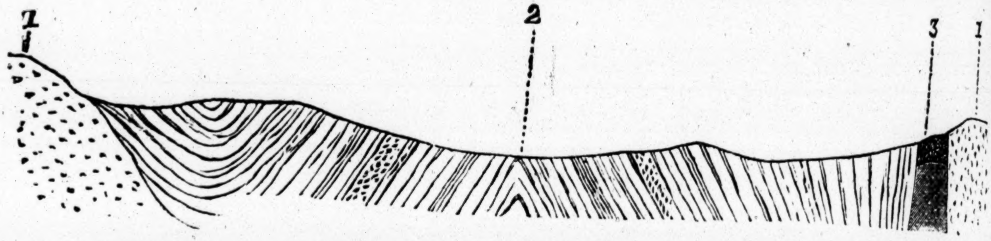
Plate 1.



Sketch-map to shew the chief mines of Iron pyrites in the province of Huelva Taken mainly from the Spanish Report on Rio Tinto.

have their greatest length in an easterly and westerly direction."* The section on Fig. 1 shows the general arrangement of the rocks in the neighbourhood of Rio Tinto.

FIG. 1. GENERAL SECTION AT RIO TINTO.*



1. Porphyry. 2. Clay-slate, &c. 3. Pyrites with overburden of oxide of iron.

Except in size, the mineral masses differ but little from one another, and the characters common to all are as follows:—The ore is granular iron-pyrites, with a very small mixture of copper-pyrites, and about four per cent. of silica: here and there are slight traces of other ores, of copper, lead, and zinc. The ore, instead of being distributed, as is the case in most mineral veins, in strings, layers, or bunches, among unproductive "veinstuff," forms a homogeneous mass, unmixed with any foreign matter, or traversed only by a few insignificant veins of quartz. In the larger deposits "riders" of rock do sometimes occur, splitting up the mass, more or less, into several subdivisions; but these are as distinctly marked off from the body of the ore itself as the rock of the surrounding country. The horizontal section is rudely lenticular in shape, its longer axis ranging parallel to the strike of the slates in the neighbourhood. No bottom has been reached in the larger deposits, but some of the smaller masses have been followed downwards till they thinned away altogether.

These masses of ore are surrounded by a belt of altered slate, known to the miners as the "Salbanda," from the German "Sahlband," consisting in the main of bleached and porcelanized rock: the part, however, immediately in contact with the ore is often soft and crumbly, seemingly from the effect of chemical action occurring at the junction.

The ore itself never shows at the surface, but is covered by a "gossan" or "overburden," consisting in the main of oxide of iron, mixed with red clay and fragments of the adjoining "country," slate, or porphyry, as the case may be. There can be little doubt that this is the result of atmospheric decomposition of the pyrites: at Rio Tinto lumps of it have been found, containing unaltered pyrites in the centre.* The overburden varies in thickness at different mines, being very rarely as little as 20, and sometimes as much as 160 feet: on an average perhaps about 40 feet.

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* Spanish report on Rio Tinto, where will also be found a detailed account of the lithology of the district.

The ground covered by the gossan is usually lower than the level of the surrounding country, and looks as if it had sunk bodily, while the Sahlband stands up as a wall all round: the cause of this depression seems to be unequal atmospheric denudation, caused by the unequal hardness of the crumbly oxide and the firm Sahlband. A fanciful notion among the Spanish miners is, that the ore boiled up in a melted state from below till it reached the surface, and then shrank in cooling.

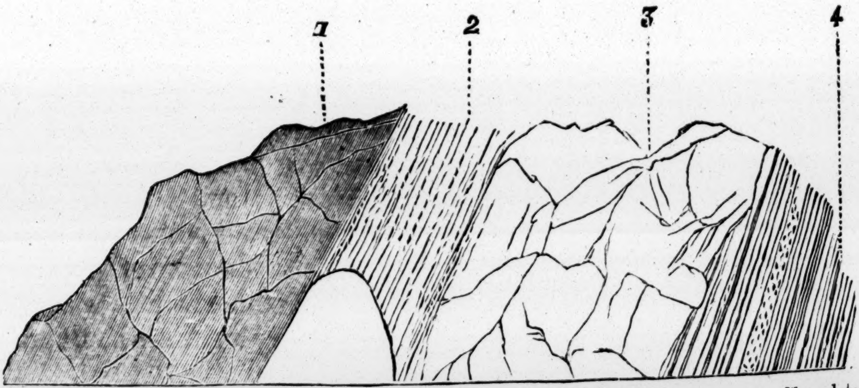
The Sahlband and the depressed crust of oxide of iron form sure guides by which we can detect, without underground explorations, the presence of a pyritous mass, and determine its shape and size. Some caution, however, is needed, for other deposits of oxide of iron occur, which to the unpractised eye are very like those which overlie a mineral mass, but beneath which no ore will be found. These may be called "false caps" of oxide of iron. Many of these have doubtless been formed by water charged with oxide of iron, produced by the decomposition of pyrites, for like deposits, the recent origin of which is proved by their containing bits of slag, are now being laid down by the water issuing from the mines. Some of these "false caps," however, are found in places where no stream can now flow: in this case they may have been deposited when the surface configuration of the country was different from what it is now; or they may be the remnants of a pre-existing pyritous mass, the greater part of which has been denuded away, and the remnant entirely oxidized. If the latter explanation be correct, extra precautions will be necessary when exploring for a deposit of pyrites, for while surface indications give the position and horizontal section, boring will be required to determine whether any unaltered mineral remains below the oxidized crust.

The general look of the country is tame and monotonous: after a time, however, the constant repetition of the same features begins to impress forcibly on the mind their very peculiar character. As far as the eye can reach, there stretches what looks like an unbroken flat, thickly overgrown with gum-cistus. Entering on this seeming plain, we find that it is deeply channelled in every direction by steep-sided brook and river valleys; but till we actually stand on the edge of one of these valleys there is scarce anything to lead us to suspect their existence: looking back, we wonder what has become of those precipitous glens down which our horse so carefully planted each footstep, and up which he so laboriously toiled, for the country looks an unbroken flat; ahead it is to all appearance the same, though closer acquaintance will show us how deceitful looks are. With scenery so marked daily before the eye, a conviction is very forcibly brought home to the mind that the country was once just such a plain as it now seems to be, and that the valleys were carved out afterwards, and all weariness at the monotony of the landscape vanishes in the delight of realizing the idea of a Plain of Marine Denudation, not by the aid of maps, sections, and description, but the thing itself, the size of nature, yet as clearly shown as in a model.

We may now turn to a few of the mines at work, beginning with that of Santá Domingo,* in the province of Alemtejo in Portugal, not far from the Guadiana and the Spanish frontier.

The deposit, which is of the usual lenticular shape, but irregular in outline, is between 500 and 600 mètres long and 70 mètres across at the widest part, and is split up by several "horses" or "riders" of slate: the ore is uncrystallized iron-pyrites of a dull grey colour, intimately mixed with a small percentage, from 2½ to 4, of copper-pyrites; the latter sometimes occurs in larger quantity, and hard specimens may be picked out containing perhaps 20 per cent. of copper. Galena and other minerals are also sparingly present, and the joints are thinly coated with carbonate of copper.

FIG. 2. SECTION ACROSS THE ADIT AT SANTA DOMINGO.



1. Pyrites. 2. Soft part of the Sahlband. 3. Porcelanized rock. 4. Clay-slate.

Fig. 2 is a section across the adit. The plane of separation between the mineral and the sahlband was most distinctly marked and haded to the north at an angle of from 45° to 80°: it was marked at some spots by beautifully polished slickenside. The sahlband itself consisted of a belt (2), next the ore, of a white, soft, quartzose rock, about 2 or 3 mètres broad; beyond this is a belt, said to be as much as 30 mètres broad, of very hard, flinty, porcelanized rock (3), white with narrow red stains: this passes outwards into slate rock. Here and there in the outer belt is seen a breccia of porcelanized rock and white quartz cemented by oxide of iron. The altered rock seems to be the result of intense heat acting under pressure; the breccia and slickenside point to movements and rending of the rocks, the fragments being afterwards cemented by water percolating from the ore through the resulting fissures. The soft belt is probably only a portion of the porcelanized rock corroded by decomposing agents produced by chemical action at the junction with the ore: such action is constantly going on, for the roofs and walls of the mine are thickly coated with incrustations and stalactites of sulphate of copper, and the water that flows from the workings holds in solution much of this and other salts.

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* I gladly take this opportunity of acknowledging the courtesy of Mr. Mason, the managing partner, who entertained us during our stay.

The mine is entered by inclined adits, and where these strike the ore, a level is carried in the sahlband of the southern or foot-wall alongside the mineral mass: the overhanging of the solid mineral, which to a certain extent protects the tunnel, makes this side the best for driving. At right angles to the level, galleries or "cross cuts," about 40 feet high, are driven across the mass to the northern wall, ribs or pillars of ore being left between to support the roof. The ore is carried by boys in baskets, made of esparto grass, into the tunnel, drawn up to day in waggons, and conveyed on a railway, with startling curves and gradients, to the shipping-port on the Guadiana.

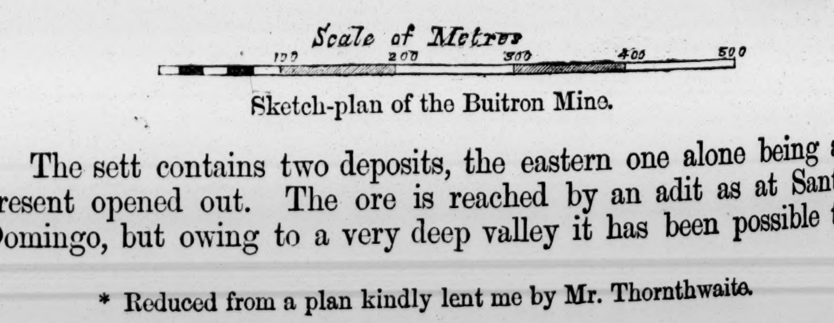
Thus much of the mine itself: but the spot has an interest for others besides the miner and geologist. In the middle of this wild country, on a spot which but a few years ago was as lone and barren as all around it is still, there has sprung up a good-sized village, with the offices, stables, and outbuildings of the mine, a church, and the handsome house of the resident partner: weekly markets are held, and the place boasts its clergyman, doctor, and police. All this change has been brought about by the energy of a single man, to whom and to whose like the country owes no small debt of gratitude. For this material civilization cannot fail to lead some day to higher results. It will be envied and sought after by the people of the land, and will be found to be beyond reach so long as their present ignorance lasts. To obtain it, education in the highest sense is not needed, but some degree of knowledge is; and even if this be of the most technical kind, and have only the lowest ends in view, it cannot fail to rouse and strengthen the mind; and men, taught to think for themselves on one class of subjects, will soon shake off the fetters of dogmatism, and do the same on all; and thus by a side-wind we may hope that education proper will find its way into a land where any attempt to introduce it directly would be put down as profane, or revolutionary, or both. Undertakings such as this, whether they are started with such a view or not, are true missionary work, and almost the only kind of missionary work practicable under the circumstances.

Of the large mineral deposits, that of the Tharsis comes next in geographical order. A plan is given in Plate II.,[*] from which it will be seen that there are four large masses of ore, all of which are clearly pointed out by surface indications, and have been proved by shafts and borings, though mining has been carried out only in one. The "gossan" reaches here at some spots the great thickness of 130 feet, and is believed to average 110 feet. The ore was at one time extracted by underground workings; but now, in spite of the difficulties attending the removal of the vast "head" of unproductive matter, it is entirely raised in "opencast," and the mine is really a large quarry. The property has lately passed into the hands of a Scotch firm, and is being energetically opened out.

The mine of the Coronada, about three leagues west of the Tharsis, has been worked in bygone times, and one of the old adits has lately been cleared out by modern adventurers: it shows well the nature of the work of the "old man," running up and down hill, and winding in a tortuous way, seemingly for the purpose of avoiding the harder portions of the rock, which could not be cut through without blasting, and round or over which the crafty miner worked his way, choosing soft ground even at the risk of extra driving. The remains of an old wooden wheel used for unwatering the mine were also found; it seemed to have worked on the principle of a dredging-machine, being fitted with buckets, which dipped into and raised the water, till, after passing the highest point, they became inverted, and discharged their contents into a gutter. A like contrivance is now, or was lately, in use at the Tharsis.

We may now turn to the Buitron Mine, near the town of Valverde, of which a sketch-plan is given in Fig. 3.

Fig. 3.



Sketch-plan of the Buitron Mine.

The sett contains two deposits, the eastern one alone being at present opened out. The ore is reached by an adit as at Santa Domingo, but owing to a very deep valley it has been possible to

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[*] Reduced from a plan kindly lent me by Mr. Thornthwaite.

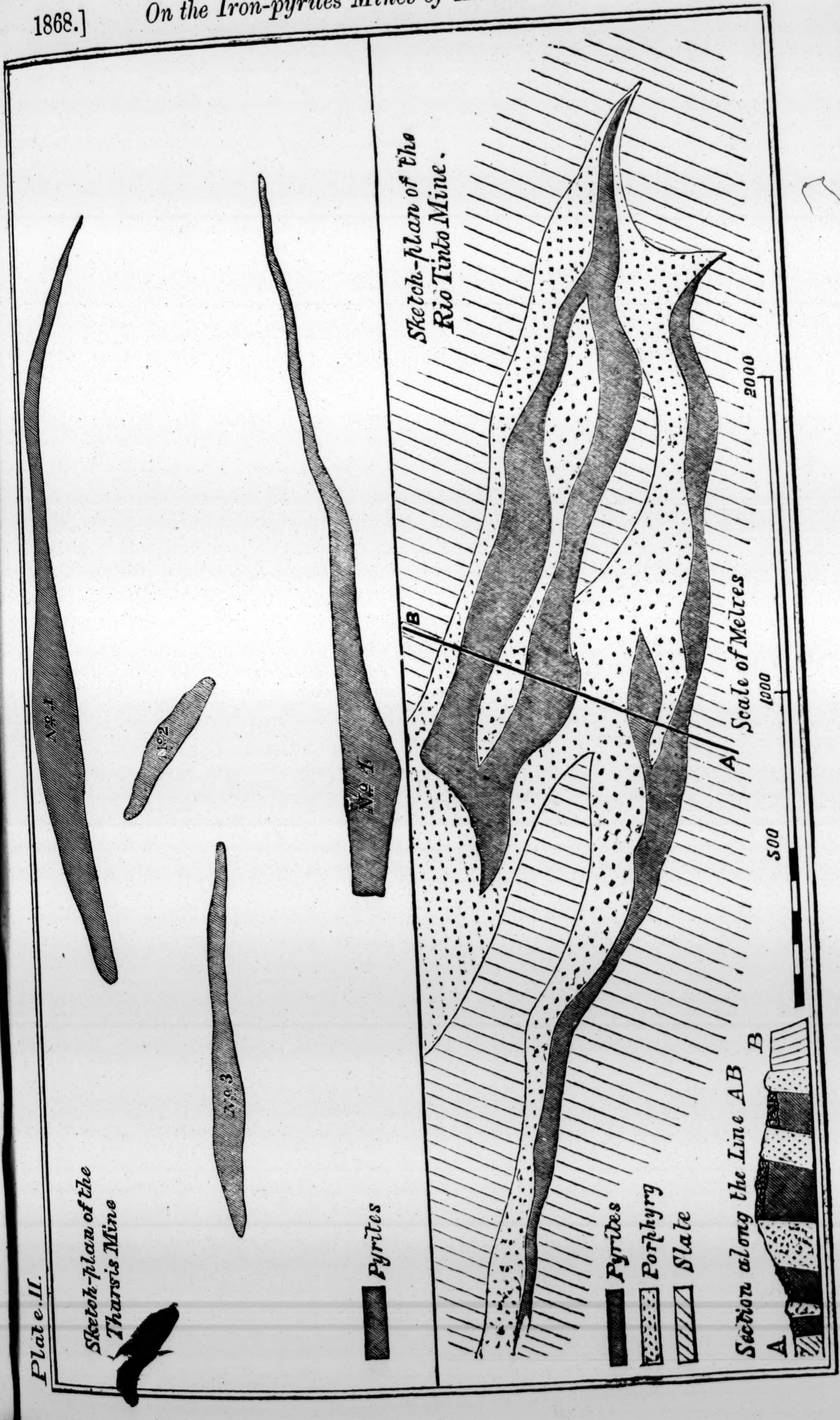
Plate II.
Sketch-plan of the Tharsis Mine
No. 1
No. 2
No. 3
No. 4
Pyrites
Sketch-plan of the Rio Tinto Mine.
B
A
Scale of Metres
2000
1000
500
Pyrites
Porphyry
Slate
Section along the Line AB
A
B

drive this adit level, and the mine is unwatered to a considerable depth by natural drainage, an immense gain in a country where scarcity of fuel makes pumping by steam-power an almost ruinous expense. The property has only lately come into the hands of the present company, who are energetically pushing forward their operations, and have laid down a railway to the port of Huelva. There are estimated to be 4,000,000 of tons of ore above the level of the present adit, and there is little doubt that the present adventurers will reap as rich a harvest as has fallen to the lot of their predecessors at Santa Domingo.

About four leagues to the north of the Buitron is the Government mine of Rio Tinto, to which I paid a hasty visit in company with Señor Don Manuel Ortegosa, to whose guidance I owe much both on this and other occasions. The ground-plan in Plate II. is reduced from that given in the Spanish report above quoted, and the following account taken from Mr. Thomas's pamphlet:— "Within the sett there are three lodes which traverse it from east to west. The northern and central ones are divided for the greater part of their length by a wedge of porphyry, but meet at either extremity. The southern lode is of greater length than the northern and central ones, and is separated from them by a larger wedge of country than they are from one another. It is to this deposit that the workings of the Spaniards have been confined; it has been opened up by them for a length of 500 mètres, its average width for that distance being 71 mètres nearly. The thickness of the overburden over the part worked is about 25 mètres." Much cannot be said for the management of the mine: shortly before my visit a "crush" had taken place which had deranged the ventilation, and I believe a similar accident has happened since. The drawing-tackle consisted of one gin, of enormous size and ill-balanced, worked by a team of mules, at least one-half of which were required to start and keep going the dead weight of the cumbrous machine, whose creakings and groanings as it was dragged painfully round mixed with the shrill torrent of incessant abuse by which a Spanish driver urges on his animals. It must not be supposed that this blundering, of which further examples might be quoted, is due to any want of skill on the part of the managing engineers, who are fully up to their work; but any suggestion of theirs must be submitted for the approval of officials at Madrid; and our experience of red-tape at home, when matters of science are concerned, will give us some notion of what must be the fate of any proposals for improvement in Spain.

History and Uses of the Mineral.—The vast heaps of slag found in the neighbourhood of most of the deposits, and the old shafts and adits, show that the mineral has been largely worked in bygone times. No certain traces of the Phœnicians and Carthaginians have been met with; and those Roman remains whose date can be fixed belong to the times of the emperors Nerva and Honorius.[*] Strabo's remarks on Spanish mines[†] are vague, and none of the localities he mentions can be identified with those treated of in this paper. In one passage, however, he mentions, quoting Posidonius, that the people of Turdetania (nearly the same as Andalucia) drive their levels *zigzag* and deep; and to get rid of the streams of water they encounter, employ Egyptian spiral pumps.[‡] The levels and water-wheels at the Coronada, already described, agree so closely with this description, that we can have no doubt about referring them to the Roman period. The ore was worked by these early miners for the small percentage of copper which it contains, and the metal extracted by smelting: their industry is shown by the immense heaps of slag they have left, especially at Rio Tinto, which Mr. Thomas suggests may have been a centre of smelting; and an examination of these slags shows that their skill was far superior to that of the Spaniards during the first half of the present century.

Leaving these uncertain traces of the old miners, we find that the mine of Rio Tinto was reopened about 1727, and has been worked since 1849 by the Spanish Government. Before the latter date the metal was extracted by smelting; but since 1849 a process has been employed known as Cementation, which is as follows:—The ore is first calcined in heaps in the open air: a small quantity of brushwood and roots of trees is used as fuel to light the pile, which, when once on fire, burns of itself. By this means a certain amount of the insoluble sulphide of copper is converted into soluble sulphate. The calcined ore is then placed in tanks of water, and when the latter has become saturated with the salts of copper and iron, it is run off into another tank, where the copper is precipitated on lumps of pig-iron. When a sufficient thickness of precipitate has accumulated, it is scraped off, and made into balls, which are dried in a kiln: these are reduced in a German blast-hearth, and the proceeds refined in a reverbatory furnace and cast into pigs. The results are far from satisfactory, as little more than half the copper contained in the ore is extracted; a far better method is that of "kernel roasting," as practised at Agordo in the Venetian States, for an account of which the reader may consult Dr. Percy's 'Metallurgy of Copper.' We may also note that the water flowing from the mine is strongly impregnated with salts of copper: it is collected in long wooden troughs, and the metal precipitated by iron.

By the cementation process all the sulphur in the ore is lost, passing off as sulphurous acid, the fumes of which destroy the surrounding vegetation, and corrode the iron used in the neighbouring buildings. It is only of late years that the ingredient just mentioned has been turned to account; but the commercial success of using the mineral as a source of sulphur has been so great, that it is now looked upon more as a sulphur than a copper ore. Up to 1840 Sicilian sulphur was chiefly used in the manufacture of sulphuric acid, but about that time the King of Naples granted a monopoly of the export of Sicilian sulphur to Messrs. Taix and Co., of Marseilles, and the price of the commodity was in consequence doubled. The manufacturers were thus obliged to cast about for other and cheaper sources of sulphur, and many adopted the use of iron-pyrites, procuring them at first from Wicklow and Cornwall, and since 1856 from Spain. This mineral has now almost superseded sulphur, only a small quantity of acid, which is required for chemical purposes to be of great purity, being manufactured from the latter. Details respecting the introduction of pyrites into this country and the process of manufacture will be found in 'A History of the Trade and Manufactures of the Tyne, the Wear, and the Tees,'* p. 159.

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[*] See Mr. Thomas's pamphlet, p. 5.

[†] 'Geographia,' book iii.

[‡] I have to thank my friend, the Rev. T. C. H. Croft, of Caius College, Cambridge, for directing my attention to this passage.

The other ingredients of the ore are also turned to account by the manufacturers of the North of England. The copper is extracted from the residuum both by cementation and smelting, and in one manufactory at least the remaining oxide of iron was smelted as an iron ore; it would seem likely, however, that with regard to the last process the remnant of sulphur and arsenic would tell very much against the quality of the metal obtained.

The above sketch deals mainly with facts; for though I would gladly have attempted some explanation of the method of formation of these strange mineral masses, I felt that with the scanty data at my disposal any such attempt would have been rash theorizing. My own visit was too hurried, and my time too much taken up with other matters, to leave leisure for questions of purely scientific interest; and the works I have had access to treat the subject more from a mining than a geological point of view.

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* London: E. & F. N. Spon, 1863.

IV. ARTIFICIAL IRRIGATION.

It is undoubtedly one of the most important duties entrusted to man that he should learn to control the elements, and by bringing science and art to bear upon the works of Nature, to render them subservient to his will in promoting the general welfare of the human race, and in contributing to its every-day requirements. Thus we see that destructive element, Fire, fairly brought into subjection, and forced to contribute to our wants in a thousand different ways. The Earth yields its hidden treasures for a similar purpose, and every description of soil which covers its surface has its allotted task to perform; whilst Air and Water, in addition to being absolute necessities of existence, have yielded the force and power with which they are invested to be applied in an infinite variety of ways to the wants of mankind.

In many parts of the world where rain is uncertain, or only occurs at stated periods of the year, it would be impossible to carry on cultivation to an extent sufficient to produce food for the inhabitants, without the aid of some artificial means by which water could be applied to the land, when most required by the growing crops. This fact seems to have been recognized many centuries ago in France, Peru, China, Spain, Italy, and in the East Indies, and at a still earlier date in Africa, systems of irrigation being clearly traced as having existed in the ages of the early histories of those countries. Few are perhaps aware of the extraordinary fertilizing powers of water even upon a barren sandy desert; but it has been proved by actual demonstration that the whole of Sindh, the greater part of which is marked on some of our maps of India as the "Great Desert," might be turned into a perfect garden merely by diverting some of the waters of the Indus, which now run away into the sea, and applying them to the parched-up land. Again, along the banks of the Suez Canal fertility has in many places succeeded to a sterility of probably some thousands of years' existence, and there is no practical reason why the entire desert, now for the first time cultivated only in parts, should not in course of years again fulfil the Divine mandate and "bring forth herbs, and fruit for the use of man."

Artificial irrigation consists in conducting water from some natural source of supply, such as rivers, springs, or lakes, by means of channels, or ducts, to the cultivated land which it is desired to irrigate. In some places this is done by throwing dams across rivers so as to raise their levels, and by forcing the water into a canal cut from the river at some point above the dam; the canal is then carried along the highest ground consistent with giving a sufficient slope to its bed to ensure a regular flow of water, from which minor channels are led off for the purpose of distributing the water to the various fields or divisions of land. Where existing lakes are to be found, the process of leading off the water in canals is simple enough, but artificial reservoirs are often constructed by damming up a gorge in a range of hills, in which is collected and stored all the rainfall draining into it; and where rock abounds a practice prevails in some parts, of excavating a subterranean passage having the usual slope of an irrigation canal, in the direction where water is supposed to exist. We shall notice these various methods of obtaining supplies of water for artificial irrigation more in detail hereafter, when the several varieties of each form of work will also be further described.

It is impossible now to state, with any degree of certainty, which was the first country to introduce a system of irrigation, but it would appear from the records in our possession that the palm of priority must be yielded to Spain over Italy, but France was probably before Spain, and Africa anterior to any in Europe. Whether irrigation was introduced into Africa before the second century it would be difficult now to determine, but if not, then the Peninsula of India may perhaps claim to have first received the benefits of irrigation. Mr. Markham, in his 'Report on the Irrigation of Eastern Spain,' states that the works of irrigation which are met with along the eastern coast of Spain from Cartagena to the mouth of the Ebro, in the old Arab kingdoms of Murcia and Valencia, "all owe their origin, and the rules and customs by which they are managed, to the ancient Arab rulers of the Peninsula, and have been in working order for upwards of a thousand years; though in some instances they have been enlarged and improved in more modern times. It is probable that there were some few irrigation works in this region, even in the time of the Romans, when Spanish agriculture was represented by Lucius Columella; but this is uncertain, and to the Spanish Arabs the credit is due of having instituted a system whereby the rocky deserts and dried-up valleys of the Peninsula were converted into terraced gardens and fertile *vegas.* The government of the Caliphs of Cordova, so far as its Public Works Department was concerned, was certainly the most efficient that has ever existed in the world, with possibly the single exception of that of the Yncas of Peru; and to the long period of peace and prosperity which was secured to this part of Spain by the firm and benevolent rule of the Ommiad Caliphs, is to be referred the execution of the great works of irrigation in Murcia and Valencia. Some of these works are actually ascribed to particular reigns, and there can be little doubt that all date their origin from this period, about A.D. 760 to 960. The subsequent centuries of Arab dominion were periods of strife and internal dissension, ending in a struggle or existence. Those were not times for originating public works, though the irrigation system that had been instituted in the days of the Caliphs was perpetuated and confirmed under the succeeding dynasties, until when the Christian conquerors appeared in the thirteenth century, it recommended itself for adoption, backed by the experienced benefits of five hundred years."

Turning now from Spain to Northern Italy, we have been unable to obtain any very definite information on the subject of irrigation as adopted there either in the classic times or during the dark ages; but it is not unreasonable to suppose that such works did exist at a period anterior to that of which any record exists. There are, however, to be found references to the question by writers of the Augustan era, especially the line of Virgil in the Georgics (Ecl. III.), "*Claudite jam rivos pueri, sat prata liberunt.*" An inscription of Hadrian's time commemorates the construction of an aqueduct in the vicinity of Milan; and some few scattered vestiges of dams and other works still exist, which are attributed in a doubtful way to the times of the empire from Augustus to Theodosius. The late Colonel Baird Smith, in his valuable work on Italian Irrigation, says, "That the system was to a certain extent employed there cannot of course be any doubt, but I think it most likely that water for irrigation was derived chiefly from springs, and was used to a limited extent; for had great works like those constructed for supplying cities with water, of which so many remarkable examples remain, been also used for purposes of irrigation, we should have had traces of them left to this day, far more distinct than any we now possess. Irrigation on a large scale, and by canals fed from large rivers, never seems to have existed until comparatively modern times. As in the East, so probably in Northern Italy, springs and wells, or small streams, easily diverted from their channels, were the sources of supply; and these would, of course, leave but evanescent traces on the surface of the country. It is in France that the most ancient traces of actual canals are to be found; and one of these, constructed it is supposed about the close of the fifth century, bears at the present day the name of Alaric II., king of the Visigoths.* In Northern Italy there are no such works so clearly identified, and it is in vain that we seek for detailed information on any one point connected with the system of irrigation which existed there. On this branch of the subject we must therefore be content to know only, that while irrigation certainly was employed in the valley of the Po, from the remotest epoch of which we have any record, there is every reason to think that few, if any, works of magnitude were constructed, that the extent of the system was limited, and as compared with its more modern development, of very minor importance."

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* Berra quotes from Cassiodorus (Dei Prati detti á Marcita, p. 6) two very curious letters of Theodoric I., king of the Goths, one to the Senate of Rome, directing that all possible encouragement should be given to a certain Desius, who proposed to drain and restore to culture a portion of the Pontine Marshes; the other is addressed to Desius himself, and exhibits the king as a most earnest and encouraging land improver. He promises liberal rewards in terms of great courtesy, and says he regards the operations with the deepest interest. The same author (p. 8) quotes another letter of Theodoric, in which orders are given for the payment of travelling expenses of a hydraulic engineer brought from *Africa to Rome*, to show the manner of obtaining and regulating supplies of water from rivers.

In India, the chief irrigated districts lie to the North-west, in the Punjab in the first place, and in the Peninsula in the second place. In their most important natural features the plains of Northern India and Northern Italy bear a striking resemblance to each other. Situated alike at the bases of the greatest mountain ranges on the continents to which they belong—drained alike by rivers which, flowing from regions of perpetual snow, have their volumes influenced by similar causes; possessed of slopes which, though differently distributed and arranged, are still equally well adapted to the necessities of each, belonging to the same geological epoch, and having physical structures with the same leading characteristics, it may be said of them that they are generically the same, whilst they differ somewhat in their physical aspects. Similarly, the eastern coast of Spain may, with equal propriety, be compared with the eastern side of the Indian Peninsula. Both in Eastern Spain and in the Carnatic the rivers rise in mountains below the level of perpetual snow, and are deficient in that permanence and regularity of supply which is the characteristic of more favoured irrigated regions. In both countries the rainfall is scanty and precarious, and the dry crops which are dependent upon it often fail. In both, the supplies of water for irrigation are secured by similar contrivances.

The first Indian canal of which there exists any satisfactory record dates from the year 1351, and it is stated to have been constructed by Feroze Toghlak. An interesting document discovered by Lieutenant S. A. Abbott, being a decree of the great Akbar, dated A.D. 1568, referring to the canal of Feroze Shah, which at that date had become so choked that its bed was scarcely discernible, directed that it should be excavated deeper and wider than formerly. Sixty or seventy years later new works were undertaken during the reign of Shah Jehan. The foundation of Shahjehanabad, and the natural desire to secure for his new capital and favourite residence the benefit of an abundant supply of water, induced the emperor to project the Delhi Canal. This canal, which was constructed in 1626, continued efficient for a century and a quarter. Aged men informed a British officer on survey duty in the neighbourhood in 1807, that they were finally deprived of the canal water about the year 1753, in the reign of Alumgir II. The canal of Feroze had ceased to flow in Hurriana about 1707, and at Suffidum in 1740; so that the Mogul canals became practically extinct nearly in the middle of the eighteenth century.

Irrigation works seem to have been very general in the peninsula of India under its native rulers, but in this part of India tank irrigation was, perhaps, more general than canal irrigation, although there were evidently many works also constructed of the latter class; and some very interesting ones in the southern Maratha country are clearly traceable to the Hindoo dynasty. "In the delta lands of Tanjore," says Colonel Baird Smith, "it is probable that artificial irrigation was contemporaneous with agriculture itself; but the first marked development of that native system, upon which modern improvements have been grafted, is traceable to a period corresponding with the close of the second century of our own era, and to the reign of a certain Rajah Veeranum, to whom many of the gigantic pagodas, as well as the great irrigation channels in Tanjore, are attributed."

Besides canals which were taken from the rivers of the district, tanks were (as we have already stated) largely employed in Southern India for purposes of irrigation; and some of these were formed on such a scale as fairly to be denominated gigantic. The embankment of the Poonary Tank, in the Trichinopoly district, for example, was 30 miles in length, that of the Veeranum Tank about 10 miles; and numerous others of scarcely inferior dimensions are scattered over the face of the country. All these tanks were provided with sluices for distributing the water to the fields, with escape weirs for regulating the surface level of the water, and with other necessary works of detail. The authority previously quoted refers in one of his writings to works of a similar character which were in existence in the delta of the Kistnah when the country fell into our hands in 1766. In Guntoor, two ancient channels, having all the characteristic marks of natural rivers, traverse the district in different directions, and for ages have been subservient to the irrigation of the delta. All the irrigated portion of the Madras presidency abounds in tanks, and the extent to which irrigation there is extended is truly extraordinary. An imperfect record of the number of tanks in fourteen districts shows them to amount to no less than 43,000 in repair, and 10,000 out of repair; or 53,000 in all.

In this hasty review of ancient irrigation works, an attempt has been made to record, so far as information has been obtainable, some account of the dates at which they were introduced into Europe. With respect to India, the foregoing may be taken as a very brief but concise statement of all that is known regarding their origin in that country, and their progress under native dynasties.

In all civilized countries where irrigation has once been introduced, that system of promoting agriculture has been promoted and extended. In France it is still extensively employed, more especially in the southern districts. In Eastern Spain the old Arab systems of irrigation are to be met with to this day; and it appears that the Spanish conquerors, far less civilized than their defeated foes, could, at the best, merely follow in the footsteps of the Arabs; but the enlightened subjects of the Western Caliphs had brought the science of irrigation, and indeed of all branches of agriculture, to the highest perfection. Markham, in his work above referred to, states—"Thus the irrigation systems of the Arabs continued in operation, with slight alterations and few improvements, after the Spanish conquest; the old rules and customs were adopted by the Spanish municipalities, and many of them have since been embodied in modern ordinances; and the works of irrigation have simply been kept in working order, and periodically cleaned, according to immemorial usage. The Arabs irrigated every place to which water could be conveyed, either by subterranean tunnels or ordinary canals; and most of these localities continue to present bright patches of green amidst the bare and rocky hills."

The repeated irruptions of the barbarian hordes of the north into the valley of the Po during the earlier centuries of the Christian era, led naturally to the neglect of even those works of irrigation which in happier times may have been constructed, and the rich plain of Lombardy was threatened with devastation. "A great part of the province," Bruschetti remarks, "was at this time covered with forests. Tracts, now richly cultivated, were then stagnant marshes or arid wastes. The cultivation of rice or the mulberry was unknown, and the products of the soil were the common grains required for food, and flax for clothing." The struggle against the superabundant waters, which threatened to submerge the plain, did not, however, begin for two centuries later. Before the year 1100, but at what precise date is unknown, the ancient works in the interior of Milan, originally constructed in the times of the Romans, were restored and extended. The destruction of Milan by the Emperor Frederick Barbarossa in 1162, and its subsequent re-construction on a grander scale about 1176, led to a great extension of these hydraulic works. Up to the middle of the twelfth century there appears no reference to the employment of the waters contained in these canals for irrigation. Continued local traditions, however, established the fact, that during the latter half of this century the modern system of irrigation had its origin; and it was to the intelligence of the Monks of St. Bernard, who founded the monastery of Chiaravalle, near Milan, that Lombardy was indebted for this blessing.

The date of the most ancient of the existing canals of Piedmont ascends to the commencement of the fourteenth century—the same period at which the great canal maker of India, the Emperor Feroze, was employed in the construction of the work which still bears his name.

Subsequent years saw a gradual development of the systems of irrigation, both in Lombardy and Piedmont, but they were for a long time administered in a very rude and imperfect way. No surveillance was exercised over the distribution of the waters, and every man supplied his own wants very much according to his own wishes. In the year 1474 the first indications appear of a regulated outlet being applied to the canal of Ivrea, in Piedmont, which, though of a rude plan at first, became modified and improved step by step, until the metrical module of the present day was arrived at.

Soon after the North-western Provinces of India came under the British Government, the propriety of restoring the Mogul canals began to be agitated. Attention, it is said, was first drawn to the subject by the offer of a Mr. Mercer to re-open the Delhi canal at his own expense, on being secured the whole proceeds of it for twenty years. This offer was declined, and about the year 1810 several officers were deputed to survey and report upon the lines both east and west of the Jumna. The subject was, however, soon dropped, but it was resumed with characteristic vigour during the administration of the Marquis of Hastings, who, in 1817, appointed an officer to superintend the restoration of the Delhi canal; and in 1822 another officer was deputed to survey and report upon the Doab canal. Similarly, in Southern India, the works of the natives were followed up and improved upon soon after the acquisition of the country. The hopeless state of confusion into which the Tanjore Government had fallen having led to the cession of the country to the English in 1801, the maintenance of the works of irrigation in that province, of course, devolved upon them from that time forward; and it was not long before certain defects inherent in the system began to exhibit themselves in a very clear and unpleasant manner.

The earlier works of this character, undertaken by the British in India, were, almost without exception, the restoration of ancient native works, and the defects originally existing in their construction were too often followed and imitated. On the Ganges canal, for the first time, was any entirely original work of this class attempted. Ground was broken on the 16th April, 1842, and the canal was opened, by the admission of water, on the 8th April, 1854.

It would carry us beyond the limits of a single paper were we to attempt to trace down the continued progress of irrigation works from the period of their revival in the different countries to which reference has been made in the foregoing pages; we shall, therefore, conclude this brief historic account of artificial irrigation by a short description of some of the methods adopted in their construction.

All canals taken off from rivers require a dam to be constructed across the stream, just below the point of their debouchure, and there are two distinct systems of this canal irrigation in ordinary practice, according to the nature of the country to be irrigated, and its physical peculiarities. The high table-land lying at the foot of mountain ranges, as in Northern Italy and North-western India, requires the adoption of a system very different from that pursued in the delta lands of the coast, as in Eastern Spain and Madras. The latter system consists in throwing a dam across the bed of the river, to raise the surface level of the water, which is then conducted along canals, whose mouths are above the dams, to the lands requiring it. This system is necessarily confined to alluvial tracts, which have been formed by deposits from rivers in a state of flood. In the former case, it is necessary to go back to some point high up in the river's course, whence the water can be brought on to the high land by excavation of a moderate depth, and by which sufficient command of level may be obtained to overflow the surface.

The simplest kinds of canals are those which are generally known as Inundation Canals, many of which exist in the Punjab and in Sindh, and by which the low-lands adjoining the rivers in those provinces are irrigated. Cuts are made from the river inland, for a certain distance, and are then carried in a direction generally parallel to the fall of the country, or the course of the river. By these, when the latter is in flood, the autumn crop is watered, but in the cold season, when the river is low, the canals run dry, and the spring crop thus derives no benefit from them. There are no works at the head of such canals to control the supply of water, for the course of the river Indus is so uncertain that it may completely desert the head, and the water may have to be brought in by a new mouth excavated for one season, which again may be useless in the next.

The Lake system of Irrigation is common to the plains of Lombardy as well as to the Madras Presidency. Where its introduction is practicable, this is, no doubt, a far more economical method of applying artificial irrigation, than the construction of large canal works; the former requiring generally but small expenditure, whilst the cost of the latter is run up by the numerous subsidiary works required for their completion. It does not appear necessary to say more with reference to these works; we shall therefore conclude the present article with a further notice of those subterranean channels to which we have already referred. Wellsted, in his 'Travels in Arabia,' describes this method of irrigation, as it is practised in the Bediah and other oases of Omán. He says:—"The oases of Bediah, and nearly all those of the interior of Omán, owe their fertilty to the happy manner in which the inhabitants have availed themselves of a mode of conducting water to them, a mode, as far as I know, peculiar to this country. The greater part of the face of the country being destitute of running streams on the surface, the Arabs have sought in elevated places for springs or fountains beneath it. By what mode they discover these I know not, but it seems confined to a peculiar class of men who go about the country for the purpose; but I saw several which had been sunk to a depth of 40 feet. A channel from this fountain head is then, with a slight descent, bored in the direction in which it is to be conveyed, leaving apertures at regular distances, to afford light and air to those who are occasionally sent to keep it clean. In this manner water is frequently conducted from a distance of 6 to 8 miles, and an unlimited supply is thus obtained. These channels are usually about 4 feet broad and 2 deep, and contain a clear rapid stream. Few of the large towns or oases but had four or five of these rivulets, or *feleji*, running into them, The isolated spots to which water is thus conveyed possess a soil so fertile, that nearly every grain, fruit, or vegetable common to India, Arabia, or Persia, is produced almost spontaneously." In the 'Journal of the Asiatic Society of Bengal,' the same subterranean irrigating channels are referred to as being used in Affghanistan, where they are called *Kahrezas*. Cieza de Leon, writing between 1532 and 1550 A.D., says, "The Indians of Peru had, and still have, great works for drawing off the water, and making it flow through certain channels. Sometimes it has chanced that I have stopped near one of these channels, and before we had finished pitching the tent, the channel was dry, the water having been drawn off in another direction, for it is in the power of the Indians to do this at their pleasure." Markham, referring to these works of the Yncas of Peru, states, "Trenches are cut along the whole length of the valley, becoming tunnels at the upper end, and penetrating into the rocks until they come in contact with underground springs. They are some 4 feet in height, with the floor, sides, and roof lined with stones, and are called *huirca*. At intervals of 200 yards there are man-holes in the main tunnels."

Somewhat similar works are also referred to in Baird Smith's Italian Irrigation, under the designation of *Fontanili*, as existing throughout the irrigating districts of Piedmont.

REVIEWS OF SCIENTIFIC WORKS RECENTLY PUBLISHED.

A Journey in Brazil (Agassiz). *Rambles of a Naturalist on the Shores and Waters of the China Sea* (Collingwood). *Acadian Geology* (Dawson). *Coast Defence* (Von Scheliha). Minor Works and New Editions.

A JOURNEY IN BRAZIL.*

In the winter of 1865 Professor Agassiz found it necessary to seek a change of scene and climate, and rest from work. From early life he had possessed a desire to study the fauna of Brazil, and especially the fishes, in their own home. Single-handed he would have been able to make but slight use of the opportunities presented to him during a visit to that country, although he was certain that the Emperor and the head of his government would give him every facility for his investigations.

While brooding over his difficulty, Mr. Nathaniel Thayer expressed to the Professor an interest in his proposed journey, and said, "Take six assistants with you, and I will be responsible for all their expenses, personal and scientific." This princely generosity was carried out in its largest and most liberal sense; and thus we have the origin of Professor Agassiz's Scientific Expedition to Brazil.

The volume before us contains a sketch of the Journey in the form of a diary, with here and there statements of the results of the investigations of the party: it is well calculated to interest general readers who are curious in such matters as the manners and customs of a wandering naturalist.

The voyage out was occupied most instructively: the Professor gave lectures to his assistants on various Natural History subjects, including the Gulf Stream and its Inhabitants, the Physical features of South America, Embryology, the Glacial Period, the Art of Observation, and many other subjects bearing upon the work before them, concluding with a warning against Darwinian tendencies; brief reports of the lectures being here given by Mrs. Agassiz.

Landing at Rio de Janeiro, the route of the expedition was up the coast to Pará; up the Amazon to Manaos, and on to Tabatinga, the frontier-town between Brazil and Peru: having left one of their party at that place to make collections, and two at San Paolo, the remainder returned down the river as far as Teffé, where they remained nearly a month, journeying back then to Manaos, which they made their head-quarters and general rendezvous. After the reassembling of the party, and after making some excursions on the river Ramos and the Rio Negro, their steps were retraced to Pará, and thence to Rio. Remaining in the capital, and exploring its neighbourhood, for about three months, the expedition returned to New York after a sojourn of fifteen months in Brazil.

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* 'A Journey in Brazil.' By Professor and Mrs. Louis Agassiz. 8vo, pp. 540. Boston: Ticknor and Fields; London: Trübner and Co., 60, Paternoster Row. 1868.

The known results of this expedition are too numerous to mention even in a review, and many facts and conclusions of the highest importance still remain to be worked out and verified before any cautious naturalist would venture to publish them. The chief object of the expedition was to ascertain how the fresh-water fishes are distributed through the great river-systems of Brazil; and all the excursions and independent journeys were planned in reference to this idea. Professor Agassiz estimates the number of species of fresh-water fish collected by the members of the expedition at between 1800 and 2000, or nearly twice as many species as exist in the Mediterranean. The number, however, is not so astonishing as the distribution. From Tabatinga to Pará the river differs neither in the temperature of its waters, in the vegetation of its banks, nor in the nature of its bed; yet under these circumstances completely distinct assemblages of fish are met with from distance to distance. When we consider that all the rivers of Europe united have not yielded more than 150 species of fresh-water fish, and that Professor Agassiz found in one small pond, covering about 400 or 500 square yards, no less than 200 species, mostly peculiar to that spot, we are inclined to indulge in a little scepticism. We want to know how many genera and families are represented by these 200 species, and what degree of affinity there is between the species themselves. Remembering Professor Agassiz's extreme opinions in favour of the theory of special and direct creation of species, we cannot help regarding it as possible that his "species" are not all entitled to that dignity. If they are, and are closely related, the explanation may be that the process of variation is stimulated in a vast degree by the tropical climate and physical features of the region. If both these suppositions are erroneous, we have here a Natural History marvel entirely without precedent; for we presume that the majority of Mr. Lea's species of Unionidæ, the only comparable example we know of, would be regarded as varieties by most European conchologists.

Another "sensation" discovery is that of the evidences of the Glacial Period in tropical America. Every geologist knows that the crystalline rocks of South America are extensively decomposed at the surface; but Professor Agassiz states that although the received explanation is true to a great extent, yet that a considerable portion of this so-called decomposed rock is the equivalent of the Northern Drift, presenting, however, in its wider extension and in the immensity of the accompanying denudation, features which are different from those with which we are so familiar. In short, Professor Agassiz refers the most recent deposits of the valley of the Amazons and its most recent denudation, resulting in the formation of hills of denudation nearly 1000 feet high, to the action of an immense glacier which poured down the valley from the accumulations of snow in the Cordilleras, flowed in an easterly direction, became swollen laterally in its progress by the tributary glaciers which descended from the table-lands of Guiana and Brazil, and built up an immense sea-wall as a terminal moraine, which protected its basin from the action of the sea!

We have exhausted our space in describing two of the marvels we meet with in this book; but neither the book nor its marvels are exhausted by us. To the intelligent reader we commend a careful perusal of this diary, as containing many new observations and much interesting information on the Empire of Brazil, from scientific, political, and social points of view. The naturalist and the geologist we have already placed on the scent; and the ethnologist will find much food for reflection, and possibly matter for dispute, in Professor Agassiz's conclusions on the characters of the mixed races of men, which are met with in such numerous and diverse aspects throughout the continent of South America.

RAMBLES OF A NATURALIST ON THE SHORES AND WATERS OF THE CHINA SEA.*

A book written by an Oxford M.A., M.B., Naturalist, F.L.S., &c., describing rambles, in the prosecution of which he was "actuated solely by a desire of increasing his own information, and the hope of, in some measure, advancing science,"† naturally raises great expectations. Its perusal, in our own instance, was attended by a large amount of gratification, not, however, unmingled with disappointment.

The author in his preface explains that he has incorporated into his work two papers, on the "Pratas Island" and on "The Luminosity of the Sea," taken by permission from this Journal; and other papers from the Proceedings of the Linnæan, Geological, Ethnological, and Royal Geographical Societies, and from the

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* 'Rambles of a Naturalist on the Shores and Waters of the China Sea: being Observations in Natural History during a Voyage to China, Formosa, Borneo, Singapore, &c., made in Her Majesty's Vessels in 1866 and 1867.' By Cuthbert Collingwood, M.A., M.B., Oxon., F.L.S., &c. John Murray, London.

† Preface.

Annals and Magazine of Natural History. This may account for the disconnected character of the work, successive chapters of which, in some cases, relate to distant countries, without even a reference to the intervening journey or voyage.

A large portion of the volume is occupied by descriptions of the manners and customs of the inhabitants of various countries visited by the author; and in all this there is no room for disappointment. Life in the far East is depicted with a graphic ability that makes familiar races more familiar, and renders, to certain tribes hitherto almost unknown, services resembling those of the photographer; we feel that we should recognize them if we were to fall in with them. An instance of the former kind occurs in the description of Singapore.

"Here we may see tropical vegetation in all its beauty and perfection; and here too we may meet representatives of various races, from the east and from the west, attracted by the same commercial magnet—Europeans and Asiatics all alike bringing with them their manners and customs, their religions, their costumes, unchanged—a picturesque combination, such as scarcely any other place can afford.* The foreign (Eastern) residents in Singapore mainly consist of two rival races, widely different in dress, habits, and religion, *viz.* Klings, from the Coromandel Coast of India, and Chinese."† The Klings are described as being "intensely black, not the shining black of a negro, but a dull, sooty colour, from which their eyes gleam out with great expression, half savage, half intelligent." "The Kling women are dark beauties, finely made, and dressed in flowing robes, which conceal the whole figure down to the feet, but leave the arms bare to the shoulder. Their dress sits on them gracefully, and their ornaments give them an air of barbaric splendour. Armlets of gold are worn above the elbow, and bracelets of gold upon their arms; golden rings encircle their ankles, and several finger-rings glitter on their hands; heavy ear-rings hang pendant from their ears, and one side of the nostril is pierced to give passage to a gold nose-ring, more or less chased in front. These ornaments are not unfrequently worn by one woman, and it appears to be a common practice to invest their money in these trinkets, so that a Kling woman carries a small fortune upon her person."‡

In striking contrast with these appear the small-footed Chinese ladies of Formosa. "Their dresses, consisting of a wide-sleeved tunic, cut in the formal style universal among Chinese ladies, were of the brightest scarlet, blue, or orange, embroidered with black, which contrasted well with the colour; and their full trousers were of some other equally strong material. In their hair, dressed in the elaborate Chinese teapot fashion, they wore artificial flowers made of the pith of the rice-paper plant of Amoy manufacture; and as they walked painfully along with the hobbling gait peculiar to their hoof-like feet, their figures swaying to and fro, and their arms more or less outstretched to balance themselves, they had, to us, a most grotesque appearance—but in Chinese eyes the acme of grace and loveliness, which they figuratively liken to the waving of willows agitated by the breeze."*

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* P. 242. † P. 245. ‡ P. 246.

Amongst the less-known tribes visited were certain natives of the Island of Formosa. "These people are called by themselves *Kibalan*, and are, I believe, known by the Chinese as the tame *aborigines*, in contradistinction to the raw savages who dwell on the mountains, and on the east coast more particularly. These latter are at deadly enmity with the Chinese, while the Kibalans live in close proximity, though isolated from them."† Both sexes are said to be friendly and good-natured, not given to cheating or stealing, nor treacherous like other Orientals. During the occupation of the island by the Dutch, the Kibalans were raised from a state of barbarism, educated, and instructed in the Christian religion. "The aborigines of Formosa are reputed still to have a traditional reverence and regard for white men; and it is much to be regretted that so firm and benignant a rule as the Dutch seem here to have inaugurated should have been cut short by an overpowering attack of the neighbouring half-civilized Chinese."‡ This portion of the volume is extremely interesting, and its value, as the result of diligent observation, is confirmed by the publication, in an appendix, of a vocabulary of words used by the natives of Sau-o Bay, east coast of Formosa.

In turning to details more especially connected with natural science, the materials are so ample, and are set forth in so attractive a style, that we can only say the work has again and again set us longing to explore for ourselves. As a specimen, we quote the description of a portion of the Fiery Cross coral reef, so called from the circumstance of the ship 'Fiery Cross' having been wrecked thereon.

"Taking a boat, with a couple of rowers, I left the ship and steered in search of the shallowest portions of the coral-strewn sea. A short row brought us upon a two-fathom patch, over which I allowed the boat to drift slowly; and leaning over the side and looking down into the mirror-like sea, I could admire at leisure the wonderful sight, undistorted as it was by the slightest ripple. Glorious masses of living coral strewed the bottom: immense globular madrepores—vast overhanging mushroom-shaped expansions, complicated ramifications of interweaving branches, mingled with smaller and more delicate species—round, finger-shaped, horn-like, and umbrella-form—lay in wondrous confusion; and these painted with every shade of delicate and brilliant colouring—grass-green, deep blue, bright yellow, pure white, rich buff, and more sober brown—altogether forming a kaleidoscopic effect of form and colour unequalled by anything I had ever beheld. Here and there was a large clam shell (Chama) wedged in between masses of coral, the gaping, zigzag mouth covered with the projecting mantle of the deepest Prussian blue; beds of dark purple, long-spined Echini, and the thick black bodies of sea-cucumbers (Holothuriæ) varied the aspect of the sea bottom. In and out of these coral groves, like gorgeous birds in a forest of trees, swarm the most beautifully-coloured and grotesque fishes, some of intense blue, others bright red, others yellow, black, salmon-coloured, and every other colour of the rainbow, curiously barred and banded and bearded, swarming everywhere in little shoals which usually included the same species, though every moment new species, more striking than the last, came into view."*

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* P. 45. † P. 107. ‡ P. 36.

But it is now necessary to explain the disappointment spoken of in the commencement of our remarks. We are surprised at the following passage in the chapter on the "Luminosity of the Sea:"—"Phosphorescence is here a misnomer, and an even greater misuse of terms it is to speak of phosphorescent matter. There is no phosphorus in the case, nor anything allied to it, except in the abstract meaning of the word."† This is likely to mislead. The term phosphorescence is constantly recognized by scientific men as applying to a large number of phenomena having nothing to do with the substance called phosphorus.

There is moreover a want of precision in the information supplied on some points of acknowledged interest in biology, treated of in the 'Rambles of a Naturalist.' For example, the performances of the so-called flying animals, Galeopithecus, Pteromys, &c., have been often described by observers whose accounts have tended only to increase the desire for more trustworthy details. The habits of Galeopithecus, witnessed in Borneo, are mentioned in the 'Rambles.' The account is too long for insertion, but the animal is said to have come "streaming through the air from a distant clump of trees,"‡ to have sailed from the top of one tree, and to have alighted on the lower third of the trunk of another tree, distant about 150 yards. Now the best authorities on the subject agree in representing the Galeopithecus as using its extended flank membranes only as a parachute; and the anatomical structure of the creature makes this more than probable. Its progress therefore from tree to tree, is simply by a leap, the duration of which is increased by the parachute action of the membranes; but by the laws of motion and gravitation, the duration of the leap, if the initial direction be horizontal or even descending (as represented), cannot possibly be greater than the time in which, with expanded membranes, it would simply fall from the top to the bottom of the tree from which it springs. The velocity needed to carry the Galeopithecus a horizontal distance of 150 yards in such a time as this, would leave little chance that a bone of the creature would be unbroken on its arrival at the second tree. Retardation towards the close of the leap would be impossible, inasmuch as it would cause the force of gravity to act in bringing the animal at once to the ground. We must therefore conclude that the specified distance, *about* 150 yards, must be in excess of the fact, or that the Galeopithecus must have a true power of flight. The difficulty is apparently not recognized in the 'Rambles.'

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* P. 146. † P. 393. ‡ P. 210.

A few points may be suggested for revision in a following edition. "Neritinæ," p. 25. Neritinæ are fresh-water molluscs, and are unlikely to be found on Pratas Island: should it be Neritæ? "Tryxalis," p. 40 (Truxalis?). "Modulus," p. 49 (Modiolus?), the small stony-shelled molluscs belonging to the genus Modulus seem very unlikely to have been an "article of considerable consumption by the people." "Certhosia Cyane," p. 185, should be Cethosia Cyane. The vignettes used as headings for some of the chapters are from drawings made by the author, and are nicely executed; but the plate of Nudibranchs from the China Sea is a failure, and conveys the idea of a vista showing the sea between cliffs at a distance from the beholder, with monsters many yards in length crawling on the rocks.

The work is scholarlike and engaging throughout, but will do more, by its pleasing style, to commend, than, by its original observations, to advance Natural Science.

MINOR WORKS AND NEW EDITIONS.

ACADIAN GEOLOGY.*

THE scope of this work is as extensive as its contents are varied. The author commences in anger and ends with enthusiasm. His indignation is directed, as a Nova Scotian, in the first place, against the Imperial legislation which has deprived his country "of their cherished provincial independence and direct connection with the mother-country;" and, secondly, against the Commissioners on the settlement of the north-eastern boundary, who have had the bad taste to suggest that "the old and beautiful name Acadia" had its origin in the Indian appellation of a kind of codfish.

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* 'Acadian Geology: the Geological Structure, Organic Remains, and Mineral Resources of Nova Scotia, New Brunswick, and Prince Edward's Island.' By John William Dawson, M.A., LL.D., F.R.S., F.G.S. 8vo, pp. 694. Second edition. London: Macmillan & Co., 1868.

Our author having thus given vent to his colonial indignation, settles down as a first-rate exponent of the Geology of the Acadian provinces. Commencing with the modern period, he gives a most interesting account of the Micmac "pre-historic" relics, belonging to a "stone-age" which existed in Acadia not more than 300 years ago; and he shows that, in the course of between two or three centuries, large areas have passed through the following phases:—(1) Primitive Forest; (2) Second-growth Forest; (3) Burned Barren; and (4) Cultivated Fields.

Dr. Dawson belongs to the straightest sect of the severely orthodox, and the moral that he draws is that man may not have made his first appearance on the earth at anything like so early a date as we "auld warld" folks believe.

The Post-pliocene period is represented by raised beaches, terraces, gravel ridges, marine clay, and, oldest of all, a wide-spread deposit of boulder-clay, the formation of which is, in the main, referred by Dr. Dawson to the action of floating ice; and he considers that glaciers played a very small part in bringing together these various drift-deposits.

The Acadian geologist then encounters a vast gap—a lapse of geological time of immense duration entirely unrepresented,—for the whole of the Pliocene, Miocene, and Eocene deposits are entirely absent, while the Cretaceous, Oolitic, and Liassic strata are equally wanting. The cause of this hiatus is debatable; probably it was that the Acadian region formed dry land during those immensely long and continuous epochs; but it is possible, though barely so, that they were buried at a great depth beneath an ocean over whose bottom no deposits were accumulated; it is also within the range of belief that strata of these periods were once formed in Acadia, and have since been entirely swept away.

Triassic rocks form almost the whole of Prince Edward's Island, and occur also as a narrow belt along the eastern shore of the Bay of Fundy; but the period immediately preceding it—the Permian—is another blank in the history of this region, unless we may regard the upheaval and contortion of the Carboniferous strata as preserving for it a species of illustration.

The Carboniferous period is richly represented both by rocks and by fossils; and the greater portion of Dr. Dawson's book is occupied with its description. Much of this material, however, has been previously published in the Quarterly Journal of the Geological Society, and has been noticed in our Chronicles of Geology. We need, therefore, only mention that the Carboniferous rocks of Acadia have yielded the first indications of reptiles of that age; and have produced the only known Enaliosaurian and Land-shells, and the first known Myriapod, of that ancient date.

The Devonian period of Acadia was remarkable for its rich vegetation, and for its ancient air-breathing insects,—the oldest of all known land-animals; while to the igneous outbursts of this era Dr. Dawson refers the formation and upheaval of the metallic riches of the region.

The Silurian rocks were spread out on the shores of the rocky lifeless continent which then stretched westward from Labrador; the commencement of the period being characterized by muddy shallows and coral-reefs in the deeper sea; the termination of it witnessed the breaking up of this sea-bed, and the production of greater inequalities by extensive processes of upheaval and disturbance, accompanied by a gradual but entire change in the animal life of the region, leading up to that assemblage which characterized the Devonian epoch.

At the base of all these deposits occur the great Laurentian and Huronian series,—the former deposited in an ocean of whose shores we are utterly ignorant, and the latter characterized by the disturbance of its quietude, the breaking up of its bed, the metamorphosis of its sediments, and the ejection of vast showers of lava, ashes, and scoriæ.

Thus, in a few words, we have a sketchy outline of the Geology of Acadia; and we have only now to ask, What new lesson does this wondrous history teach us? Does it explain anything of which we were formerly ignorant, or does it expose the naked pinchbeck which we once mistook for the gold of truth?

Dr. Dawson thinks he can infer something comparatively new; and he also tries to prove untrue something that is now comparatively old; and both these efforts relate to a kindred subject, perhaps we should say to the same. In other words, he reproduces his idea of Geological Cycles, regarding each great geological period as forming a geological cycle in which the diversified conditions of land and water were, to a certain extent, successive; and he strives to show that the theory of Homotaxis is utterly erroneous, and that, for instance, the Carboniferous formation is, as a whole, and to a great extent, division for division, the contemporaneous equivalent of the European Carboniferous system.

We ought to mention, in conclusion, that the work is illustrated by an excellent engraved geological map, printed in colours; and by a large number of woodcut views, sections, and figures of fossils.

DANA'S SYSTEM OF MINERALOGY.*

As the previous edition of this standard work was exhausted eight years ago, a re-issue has long been anxiously anticipated. Indeed, there is so deplorable a poverty of mineralogical literature in the English language, that the student can ill afford that any work of value should remain inaccessible. The failing health of Dr. Dana, coupled with a desire on his part to introduce certain improvements into the present edition, has tended to delay the publication from time to time. At length, however, with the co-operation of Professor Brush, he is enabled to give us the long-expected volume.

On opening the book—a bulky octavo of nearly 900 closely-printed pages—one feels somewhat disappointed to find that, with the exception of about fifty pages of introductory matter, the present edition embraces only the descriptive portion which formed the second volume of the earlier work. Although the preface is silent on this point, we understand that the author proposes to issue a new edition of his first volume in the shape of an independent treatise.

Among the many improvements noticeable in the volume before us, we may especially allude to the introduction of a system of historical synonymy,—a feature which greatly enhances the value of the work, since it forms a guide in tracing the history of any given species. The consultation of original authorities for these synonyms must have involved a considerable amount of literary research. This research has led the author to a revision of our mineralogical nomenclature, by which he attempts to recognize, as far as possible, the law of priority in selection of names. This has of course necessitated the revival of many obsolete names, whilst an attempt to secure uniformity of nomenclature has led to the introduction of many new ones.† Thus, for example, Rock Salt is described under the new name of *Halite,* whilst Zinc-blende is to be found under Glocker's old name of *Sphalerite.* In other cases, the terms are only modified by altering their terminations into *ite,* and in this way we get such names as *Galenite, Pyrrhotite, Castorite,* &c. Again, Kupfernickel is termed *Niccolite,* and our hybrid adjective *nickeliferous* assumes the more consistent latinized form of *niccoliferous.* Indeed "nickeliferous" is not a better word than "copperiferous." Nevertheless it is doubtful whether such innovations will hold their ground, in spite of their introduction under the prestige of so respected an authority as our author.

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* 'A System of Mineralogy: Descriptive Mineralogy, comprising the most recent Discoveries.' By James Dwight Dana, aided by George Jarvis Brush. 5th edition. 8vo. New York, 1868.

† For an exposition of Dana's views on 'Nomenclature,' see 'Quarterly Journal of Science,' Jan., 1868, p. 105.

Writing at a time when chemistry is verging on a new phase, Dana very prudently effects a compromise between the new and the old theories by writing his formulæ in accordance with both. Another improvement in the present edition is the systematic recognition of the *varieties* of each species.

Although Professor Brush's name appears on the title-page of this edition, it would seem that his labours relate only to the pyrognostic characters of the minerals described. "Neither the consultation of original authorities, the drawing of conclusions, nor the putting of the results on paper, has been delegated to another. And being now," continues the author, "but half-way between the fifties and sixties, it is my hope that the future will afford another opportunity for similar work." In this hope, every mineralogist will heartily concur.

ENGINEERING WORKS.

A TREATISE on 'Coast Defence,' by Von Scheliha, Lieutenant-Colonel and Chief Engineer of the department of the Gulf of Mexico, of the army of the late Confederate States of America,* deserves more than a passing notice, containing as it does a very comprehensive account of the means for the attack and defence of coasts, as practised in modern warfare, backed by the experience gained during the late American war. Thus it forms a very valuable addition to works on Military Engineering, and will doubtless be found a useful text-book for the study of naval and military officers.

It will readily be admitted that the progress made in naval architecture, and in artillery, necessitates some modification of the principles heretofore observed in coast-defence. The increased power of the guns of the present day would knock to pieces any fort that was constructed twenty or even ten years ago, and the masonry walls of recent years must now give place to iron sheathing. Wherever practicable, a well-turfed earthen slope is, however, still a safe protection in many cases; but the recent invention of Lieutenant Moncrieff's elevating gun-carriage will, if found practicable in service, go far towards inverting the present practice of coast-defence, and pits will be dug for the guns instead of building forts; thus they would be entirely protected from all, except shells, and no doubt means will soon be devised for keeping them out also. In the work under our notice the advantages of railroad communication along the sea-shore are forcibly pointed out, as a means whereby the scattering of forces by fortifying places of secondary importance may be avoided; on this point there can be no manner of doubt, but efficient training of a military railway staff would in all cases be desirable, and the railway itself should, as far as possible, be concealed or otherwise out of range of the attacking force, forming, as it were, a covered way of communication between the principal points of defence.

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* London: E. & F. N. Spon, 1868.

The effects of bombardments which took place during the American war on the different kinds of forts has furnished materials for a chapter on the relative advantages of masonry, earth, and sand works, as a means of protection against modern artillery. The disadvantage at which all forts stand before modern armour-clad fleets leads to a discussion of the necessity of blocking up the channels by which they may be approached, either by sunken or floating obstructions, or by torpedoes of various descriptions; the former preventing the too near approach of hostile vessels, and sometimes holding them in check at a point where they may be exposed to a cross-fire from masked batteries, whilst torpedoes are calculated to disable a vessel at once, and so place it at the mercy of the defenders. A considerable portion of the work is given to the consideration of this kind of obstructive defence, and in it is embodied much useful information on that point. The subject of lighting up channels has also engaged the author's attention. This may be turned to account, either for peaceful or hostile purposes, and if properly illuminated it would be impossible for a hostile crew to approach unseen within certain limits of the shore. Throughout, the work is liberally illustrated, and altogether forms a handsome, as well as very instructive volume.

Mr. Latimer Clark has recently given us 'An Elementary Treatise on Electrical Measurement for the use of Telegraph Inspectors and Operators.'* The author of this work is sufficiently well known as one of our leading telegraph engineers, to stamp any work emanating from his pen with a degree of authority, but unfortunately, for want of proper proof corrections, one or two grave mistakes occur in the formulæ, which will, however, doubtless be corrected in a future edition; as they are palpably merely typographical errors, we refrain from noticing them here more particularly. This volume is a work quite different from any book hitherto published on electrical subjects, and it contains a mass of useful and practical information relating to electrical tests, as well as the various properties of the materials used in telegraphy. It is doubtful whether it will ever become popular amongst casual students of electrical science, but it was clearly not written with that view; to those, however, who follow telegraphy as a profession, its value will no doubt be fully appreciated.

* London: E. & F. N. Spon, 1868.

Theoretical Astronomy, relating to the motions of the heavenly bodies, &c., embracing a systematic derivation of the formulæ for the calculation of the geocentric and heliocentric places, for the determination of the orbits of planets and comets, for the correction of approximate elements, and for the computation of special perturbations; together with the theory of the combination of observations, and the method of least squares, with numerical examples and auxiliary tables. By James C. Watson. Royal 8vo, cloth, pp. 662. Philadelphia, 1868. Trübner and Co.

This is a useful treatise, going over the same ground as Chauvenet's valuable Treatise on Astronomy. The latter work is, however, the more complete. We notice also some pages in Mr. Watson's work which require revision. On the whole, however, and considering the extent and difficulty of the subjects treated of, his work is a meritorious one.

Celestial Objects for Common Telescopes. By the Rev. T. W. Webb, M.A., F.R.A.S., Incumbent of Hardwick, Herefordshire. Second edition, revised and enlarged. Longmans.

We are glad to see a new edition of Mr. Webb's valuable treatise. As a convenient text-book for the advanced amateur observer, this work is likely to hold its ground for many years. In the new edition Mr. Webb has availed himself of the advice and experience of our leading astronomers. He is himself also in the front rank among observers, a circumstance which largely enhances the value of his work. His treatise is especially valuable for those who wish to take part in the investigation of the moon's surface. We notice a new appendix, in which all the chief lunar objects are arranged alphabetically. There are also two other new appendices; one containing a list of objects in the southern hemisphere, the other giving in their order of right ascension all the stars referred to in the body of the work. There are also one or two new illustrations in the present edition. Altogether the work is one which we can cordially recommend to all those who wish to become systematic observers of the heavens.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MEETING AT NORWICH, August, 1868.

The President's Address.

Dr. Hooker referred at the commencement of his address to his own early career, which began thirty years since at the Meeting of the British Association at Newcastle. It was to his voyage then undertaken, in company with Sir James Ross, in the Antarctic seas, that his position as President on that evening, he felt, was due. He had not been able to find time to survey the rise of scientific Botany in this address, nor to discuss the relation of the allied sciences to Botany, as he had wished, but he proposed to touch on various matters which appeared to be of interest at the present time. First of all, it was necessary to introduce the International Congress of Pre-historic Archæology, who were to hold their meetings at the same time as those of the British Association. Sir John Lubbock was to preside over this meeting, and it would, Dr. Hooker hoped, receive the cordial sympathy and support of the scientific men then in Norwich. An important matter connected with the science of man had been lately under the consideration of the Council of the Association itself, which must interest equally the members of the Congress. This was the investigation of the habits, manners, form, &c., of the indigenous populations of India, especially those which erect megalithic monuments. In consequence of representations from the Council, the Government of India had set to work to obtain photographs and other information in regard to these people.

"It will, no doubt," said Dr. Hooker, "surprise many here to be told that there exists within 300 miles of the British capital of India, a tribe of semi-savages which habitually erects dolmens, menhirs, cysts, and cromlechs, almost as gigantic in their proportions, and very similar in appearance and construction, to the so-called Druidical remains of Western Europe; and what is still more curious, though described and figured nearly a quarter of a century ago by Col. Yule, the eminent oriental geographer, except by Sir John Lubbock they are scarely alluded to in the modern literature of pre-historic monuments. In the 'Bengal Asiatic Journal' for 1844, you will find Col. Yule's description of the Khasia people of East Bengal, an Indo-Chinese race, who keep cattle but drink no milk, estimate distances traversed by the mouthfuls of pawn chewed *en route*, and amongst whom the marriage tie is so loose that the son commonly forgets his father, while the sister's son inherits property and rank. Dr. Thomson and I dwelt for some months amongst the Khasia people, now eighteen years ago, and found Col. Yule's account to be correct in all particulars. The undulatory eminences of the country, some 4—6,000 feet above the level of the sea, are dotted with groups of huge unpolished squared pillars, and tabular slabs supported on three or four rude piers.

"In one spot, buried in a sacred grove, we found a nearly complete circle of menhirs, the tallest of which was 30 feet out of the ground, 6 feet broad, and 2 feet 8 inches thick; and in front of each was a dolmen or cromlech of proportionately gigantic pieces of rock.

"The largest slab hitherto measured is 32 feet high, 15 feet broad, and 2 feet thick. Several that we saw had been very recently erected, and we were informed that every year some are put up, but not in the rainy season, which we spent in the country. The method of separating the blocks is by cutting grooves, along which fires are lighted, and into which, when heated, cold water is run, which causes the rock to split along the groove; the lever and rope are the only mechanical aids used in transporting and erecting the blocks. The objects of their erection are various—sepulture, marking spots where public events had occurred, &c. It is a curious fact that the Khasian word for a stone, 'Mau,' as commonly occurs in the names of their villages and places, as that of Man, Maen, and Men, does in those of Brittany, Wales, Cornwall, &c.; thus Mausmia signifies in Khasai the Stone of Oath—Mamloo, the Stone of Salt—Mauflong, the Grassy Stone, just as in Wales, Penmaenmawr signifies the Hill of the Big Stone; and in Brittany a Menhir is a Standing Stone, and a Dolmen a Table Stone, &c."

Dr. Hooker then passed on to the question of the site and management of the British Museum, which also had been under the consideration of the Council, in consequence of a resolution passed by Section D. A deputation had been sent by the Association, consisting of distinguished naturalists who had drawn the attention of Mr. Disraeli's Government to the matter. A similar deputation had waited on Mr. Disraeli ten years since, but no action had resulted. Dr. Hooker considered there was a graver objection to the present system than those which Mr. Andrew Murray had last year dwelt on, namely, that out of the forty-five trustees there are only three who have any special knowledge of Natural History, although the national collections in their care are the most valuable in Europe.

With regard to provincial museums, Dr. Hooker considered that there should be in such a place a detailed instructional series of dissected animals and plants, clearly laid out and named; and, secondly, a distinct collection of the Natural History objects of the province. The curator should be able to give elementary demonstrations (not formal lectures) to schools and classes visiting the museum, for which a fee might be charged. The museum, too, should not be a dingy, ill-lighted place, but a bright, cheery building, placed if possible in a public park. Dr. Hooker never remembered to have heard of a provincial museum that was frequented by schools. He believed this did not arise from indifference to knowledge on the part of the upper classes, or of teachers, but to the generally uninstructive nature of the contents of these museums and their uninviting exterior and interior. He advocated strongly the removal of the Natural History collections of the British Museum to the townward end of the great parks, where persons might enjoy trees, flowers, and fountains after visiting the galleries, instead of as now being half stifled in the latter and then escaping only to still more dusty and choking streets.

The President now passed on to speak of recent progress in Botany. The researches of Unger on the Continent, and Dawson in Canada had greatly added to our knowledge of coal plants, but recently Binney and Carruthers had added still more by studying the intimate structure of these fossils. The Tertiary flora had been studied with great success by Heer, Saporta, Gaudin, and others. Dr. Hooker (evidently referring to our own Alum Bay leaf beds) did not think much importance could be attached to separated leaflets, which were abundant in many Tertiary strata. Three genera had been made by one botanist out of three leaflets of the single leaf of a plant allied to our blackberries. The greatest discoveries in Botany during the past ten years have been physiological. Dr. Hooker especially alluded to Darwin's researches on the Fertilization of Plants, and to his memoir on Climbing Plants, as also to a most important paper by Mr. Herbert Spencer "On the Circulation of the Sap and the Formation of Wood in Plants."

"The first-fruit of Darwin's labours was his volume on the 'Fertilization of Orchids,' undertaken to show that the same plant is never continuously fertilized by its own pollen, and that there are special provisions to favour the crossing of individuals. As his study of the British species advanced, he became so interested in the number, variety, and the complexity of the contrivances he met with, that he extended his survey to the whole family; and the result is a work, of which it is not too much to say, that it has thrown more light upon the structure and functions of the floral organs of this immense and anomalous family of plants, than had been shed by the labours of all previous botanical writers. It has further opened up entirely new fields of research, and discovered new and important principles, that apply to the whole vegetable kingdom.

"This was followed by his paper on the two well-known forms of the Primrose and Cowslip,* popularly known as the pin-eyed and thrum-eyed: these forms he showed to be sexual and complementary; their diverse functions being to secure, by their mutual action, full fertilization, which he proved could only take place through insect agency. In this paper he established the existence of homomorphic or legitimate, and heteromorphic or illegitimate unions amongst plants, and detailed some curious observations on the structure of the pollen. The results of this, perhaps more than any other of Mr. Darwin's papers, took botanists by surprise; the plants being so familiar, their two forms of flower so well known to every intelligent observer, and his explanation so simple. For my own part I felt that my botanical knowledge of these homely plants had been but little deeper than Peter Bell's, to whom

> 'A primrose by the river's brim
> A yellow primrose was to him,
> And it was nothing more.'

Analogous observations on the dimorphism of Flax and its allies,† formed a subsequent paper; during the course of which observations he made the wonderful discovery, that in the common flax, the pollen of one form of flower is absolutely impotent when applied to its own stigma, but invariably potent when applied to the stigma of the other form of flower; yet the pollens and stigmas of the two kinds are utterly undistinguishable under the highest powers of the microscope.

"His third investigation was a very long and laborious one on the Common Loosestrife‡ (Lythram Salicaria), which he showed to be trimorphic; this one species having three kinds of flowers, all annually abundantly produced, and as different as if they belonged to different species; each flower has, further, three kinds of stamens, differing in form and function. We have in this plant, then, six kinds of pollen, of which five at least are essential to complete fertility, and three distinct forms of style. To prove these various differences, and that the co-adaptation of all these stamens and pistils was essential to complete fertility, Mr. Darwin had to institute eighteen sets of observations, each consisting of twelve experiments, 216 in all. Of the labour, care, and delicacy required to guard such experiments against the possibility of error, those alone can tell who experimentally know how difficult it is to hybridize a large flowered plant of simple form and structure. The results in this case, and in those of a number of allied plants experimented on at the same time, are such as the author's sagacity had predicted; the rationale of the whole was demonstrated, and he finally showed, not only how nature might operate in bringing these complicated modifications into harmonious operation, but how through insect agency she does do this, and also why she does it.

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* 'Journal of the Linnean Society of London,' vol. vi., p. 77.
† 'Journal of the Linnean Society,' vol. vii., p. 69.
‡ Ib., vol. viii., p. 169.

"It is impossible even to enumerate here the many important generalizations that have followed from these and other papers of Mr. Darwin's on the fertilization of plants; some that appear to be commonplace at first sight, are really the most subtle, and like many other apparent commonplaces, are what, somehow, never occur to commonplace minds; as, for instance, that all plants with conspicuously coloured flowers, or powerful odours, or honeyed secretions, are fertilized by insects;—all with inconspicuous flowers and especially such as have pendulous anthers, or incoherent pollen, are fertilized by the wind: whence he infers that, before honey-feeding insects existed, the vegetation of our globe could not have been ornamented with bright-coloured flowers, but consisted of such plants as pines, oaks, grasses, nettles, &c."

Mr. Darwin's recent work on 'Animals and Plants under Domestication,' showed a wonderful power of utilizing the waste materials of other men's laboratories, as Mr. James Paget had remarked—and this power was, Dr. Hooker considered, most characteristic of the author. As to the theory of Pangenesis, Dr. Hooker endorsed the opinion of the President of the Linnæan Society, that this supposition "explains some facts and is not incompatible with others; it will be admitted by many as a provisional hypothesis to be further tested, and to be discarded only when a more plausible one shall be brought forward."

It was time to ask now, what progress the Darwinian theory had made in men's estimation, ten years having elapsed since the publication of the Origin of Species. 'The Athenæum' very recently assured its readers that the theory was a matter of the past, and that Mr. Darwin's last book only contained a reasseveration of his guesses founded on the variations of pigeons. Dr. Hooker emphatically denied the truth of these statements. He told how the work had been translated into every European language, and passed through many editions, and that the rising naturalists were, perhaps, rather too eager and ardent in their acceptance of the theory. The scientific writers who had publicly rejected the theory were few in number, and had been admirably controverted by Mr. Darwin's true knight, Alfred Wallace, in this Journal and elsewhere. Above all that noble man, Sir Charles Lyell, had adopted the theory in his tenth edition of the 'Principles,' not afraid to plant his work on this basis and yielding his old objections to what he now believed the truth.

After discussing the Astronomical objections urged against Darwin's theory in the 'North British Review,' and pointing out the grossly speculative character of many asserted facts in Astronomy, a science which did not rightly claim to be the Queen of Sciences, Dr. Hooker passed on to speak of Pre-historic Archæology. To this study he would accord the dignity of a science. It most clearly proclaimed to us that man himself inhabited this earth for many thousands of years before the historic period,—a result little expected less than thirty years ago, when the Rev. W. V. Harcourt, in his address to the Association at Birmingham, observed that "Geology points to the conclusion that the time during which mankind has existed on the globe cannot materially differ from that assigned by Scripture," "referring," Dr. Hooker added, "to the so-called Scripture chronology, which has no warrant in the Old Testament and which gives 5,874 years as the age of the inhabited globe."

A great deal had been recently said as to the connection between science and religion. It was most important that their attitude should be mutually considerate and friendly.

The religious teachers had not always shown this spirit, though there was a greater tendency to it now than formerly. Science and religion might work in harmony and with good will, if both parties remembered that the laws of mind are not yet relegated to the domain of the teachers of physical science, and that the laws of matter are not within the religious teachers' province.

"But," concluded the President, "if they would thus work in harmony, both parties must beware how they fence with that most dangerous of two-edged weapons, Natural Theology, a science falsely so called, when, not content with trustfully accepting truths hostile to any presumptuous standard it may set up, it seeks to weigh the infinite in the balance of the finite, and shifts its ground to meet the requirements of every new fact that science establishes, and every old error that science exposes. Thus pursued, Natural Theology is to the scientific man a delusion, and to the religious man a snare, leading too often to disordered intellects and to atheism.

"One of our deepest thinkers, Mr. Herbert Spencer, has said, 'If religion and science are to be reconciled, the basis of the reconciliation must be this deepest, widest, and most certain of facts, that the power which the universe manifests to us, is utterly inscrutable.' The bonds that unite the physical and spiritual history of man, and the forces which manifest themselves in the alternate victories of mind and of matter over the actions of the individual, are, of all the subjects that physics and psychology have revealed to us, the most absorbing, and are, perhaps, utterly inscrutable. In the investigation of their phenomena is wrapped up that of the past and the future, the whence and the whither, of his existence; and, after a knowledge of these the human soul still passionately yearns and cries."

MATHEMATICAL AND PHYSICAL SCIENCE. (Section A.)

The proceedings in this Section were opened on Thursday, August 20th, by an inaugural address from the President, Professor Tyndall, F.R.S. Space will not allow us to give this admirable address in full, but in the following abstract we have endeavoured to place the substance of it before our readers, preserving as nearly as possible the sequence of argument and the language of the speaker. Quoting Fichte,—who in his lectures on the "Vocation of the Scholar," insisted that the culture for the scholar should not be one-sided but all-sided,—Professor Tyndall said that this idea was to some extent illustrated by the constitution and the labours of the British Association. We have here a body of men engaged in the pursuit of Natural Knowledge, but variously engaged. While sympathizing with each of its departments, and supplementing his culture by knowledge drawn from all of them, each student selects one subject for the exercise of his own original faculty—one line along which he may carry the light of his private intelligence a little way into the darkness by which all knowledge is surrounded. Thus, the geologist faces the rocks; the biologist fronts the conditions and phenomena of life; the astronomer, stellar masses and motions; the mathematician, the properties of space and number; the chemist pursues his atoms, while the physical investigator has his own large field in optical, thermal, electrical, acoustical, and other phenomena. The British Association, then, faces nature on all sides, and pushes knowledge centrifugally outwards, while through circumstances or natural bent each of its working members takes up a certain line of research in which he aspires to be an original producer, being content in all other directions to accept instruction from his fellow men. The sum of our labours constitutes what Fichte might call the *sphere* of natural knowledge. In the meetings of the Association it is found necessary to resolve this sphere into its component parts, which take concrete form under the respective letters of our Sections.

Partly through mathematical and partly through experimental research, physical science has of late years assumed a momentous position in the world. Both in a material and in an intellectual point of view it has produced, and it is destined to produce, immense changes,—vast social ameliorations, and vast alterations in the popular conception of the origin, rule, and governance of things. Miracles are wrought by science in the physical world, while philosophy is forsaking its ancient metaphysical channels and pursuing those opened or indicated by scientific research. This must become more and more the case as philosophic writers become more deeply imbued with the methods of science, better acquainted with the facts which scientific men have won, and with the great theories which they have elaborated.

If we look at the face of a watch, we see the hour- and minute-hands, and possibly also a second-hand, moving over the graduated dial. Why do these hands move? and why are their relative motions such as they are observed to be? These questions cannot be answered without opening the watch, mastering its various parts, and ascertaining their relationship to each other. When this is done, we find that the observed motion of the hands follows of necessity from the inner mechanism of the watch when acted upon by the force invested in the spring.

This motion of the hands may be called a phenomenon of art, but the case is similar with the phenomena of nature. These also have their inner mechanism, and their store of force to set that mechanism going. The ultimate problem of physical science is to reveal this mechanism, to discern this store, and to show that from the combined action of both the phenomena of which they constitute the basis must of necessity flow.

There have been writers who affirmed that the pyramids of Egypt were the productions of nature; and in his early youth Alexander von Humboldt wrote an essay with the express object of refuting this notion. We now regard the pyramids as the work of men's hands, aided probably by machinery of which no record remains. We picture to ourselves the swarming workers toiling at those vast erections, lifting the inert stones, and, guided by the volition, the skill, and possibly at times by the whip of the architect, placing the stones in their proper positions. The blocks in this case were moved by a power external to themselves, and the final form of the pyramid expressed the thought of its human builder.

Let us pass from this illustration of building power to another of a different kind. When a solution of common salt is slowly evaporated, the water which holds the salt in solution disappears, but the salt itself remains behind. At a certain stage of concentration the salt can no longer retain the liquid form; its particles, or molecules, as they are called, begin to deposit themselves as minute solids, so minute, indeed, as to defy all microscopic power. As evaporation continues solidification goes on, and we finally obtain, through the clustering together of innumerable molecules, a finite mass of salt of a definite form. What is this form? It sometimes seems a mimicry of the architecture of Egypt. We have little pyramids built by the salt, terrace above terrace from base to apex, forming thus a series of steps resembling those up which the Egyptian traveller is dragged by his guides. The human mind is as little disposed to look at these pyramidal salt-crystals without further question as to look at the pyramids of

Egypt without inquiring whence they came. How, then, are those salt-pyramids built up?

Guided by analogy, we may suppose that, swarming among the constituent molecules of the salt, there is an invisible population, guided and coerced by some invisible master, and placing the atomic blocks in their positions. This, however, is not the scientific idea. The scientific idea is, that the molecules act upon each other without the intervention of slave labour; that they attract each other and repel each other at certain definite points, and in certain definite directions; and that the pyramidal form is the result of this play of attraction and repulsion. While, then, the blocks of Egypt were laid down by a power external to themselves, these molecular blocks of salt are self-posited, being fixed in their places by the forces with which they act upon each other. Throughout inorganic nature, we have this formative power,—this structural energy ready to come into play, and build the ultimate particles of matter into definite shapes. It is present everywhere. The ice of our winters and of our polar regions is its handywork, and so equally are the quartz, felspar, and mica of our rocks.

Let us pass from what we are accustomed to regard as a dead mineral to a living grain of corn. In the corn the molecules are also set in definite positions. But what has built together the molecules of the corn? Regarding crystalline architecture, we may, if we please, consider the atoms and molecules to be placed in position by a power external to themselves. The same hypothesis is open to us now. But if in the case of crystals we have rejected this notion of an external architect, we are bound to reject it now, and to conclude that the molecules of the corn are self-posited by the forces with which they act upon each other. It would be poor philosophy to invoke an external agent in the one case and to reject it in the other.

Let us now place the grain of corn in the earth and subject it to a certain degree of warmth. In other words, let the molecules, both of the corn and of the surrounding earth, be kept in a state of agitation; for warmth is, in the eye of science, tremulous molecular motion. Under these circumstances, the grain and the substances which surround it interact, and a molecular architecture is the result of this interaction. A bud is formed; this bud reaches the surface, where it is exposed to the sun's rays, which are also to be regarded as a kind of vibratory motion. And as the common motion of heat with which the grain and the substances surrounding it were first endowed, enabled the grain and these substances to coalesce, so the specific motion of the sun's rays now enables the green bud to feed upon the carbonic acid and the aqueous vapour of the air, appropriating those constituents of both for which the blade has an elective attraction, and permitting the other constituent to resume its place in the air. Thus forces are active at the root, forces are active in the blade, the matter of the earth and the matter of the atmosphere are drawn towards the plant, and the plant augments in size. We have in succession the bud, the stalk, the ear, the full corn in the ear. For the forces here at play act in a cycle which is completed by the production of grains similar to that with which the process began.

Now there is nothing in this process which necessarily eludes the power of mind as we know it. An intellect the same in kind as our own would, if only sufficiently expanded, be able to follow the whole process from beginning to end. No entirely new intellectual faculty would be needed for this purpose. The duly expanded mind would see in the process and its consummation an instance of the play of molecular force. It would see every molecule placed in its position by the specific attractions and repulsions exerted between it and other molecules. Nay, given the grain and its environment, an intellect the same in kind as our own, but sufficiently expanded, might trace out *à priori* every step of the process, and by the application of mechanical principles would be able to demonstrate that the cycle of actions must end, as it is seen to end, in the reproduction of forms like that with which the operation began. A similar necessity rules here to that which rules the planets in their circuits round the sun.

In the eye of science *the animal body* is just as much the product of molecular force as the stalk and ear of corn, or as the crystal of salt or sugar. All that has been said regarding the plant may be restated with regard to the animal. Every particle that enters into the composition of a muscle, a nerve, or a bone, has been placed in its position by molecular force. And unless the existence of law in these matters be denied, and the element of caprice introduced, we must conclude that, given the relation of any molecule of the body to its environment, its position in the body might be predicted. Our difficulty is not with the *quality* of the problem, but with its *complexity;* and this difficulty might be met by the simple expansion of the faculties which man now possesses. Given this expansion, and given the necessary molecular data, and the chick might be deduced as rigorously and as logically from the egg, as the existence of Neptune was deduced from the disturbances of Uranus, or as conical refraction was deduced from the undulatory theory of light.

Associated with this wonderful mechanism of the animal body, we have phenomena no less certain than those of physics, but between which and the mechanism we discern no necessary connexion. A man, for example, can say *I feel, I think, I love;* but how does *consciousness* infuse itself into the problem? The human brain is said to be the organ of thought and feeling: when we are hurt, the brain feels it; when we ponder, it is the brain that thinks; when our passions or affections are excited, it is through the instrumentality of the brain. We may admit the extreme probability of the hypothesis, that for every fact of consciousness, whether in the domain of sense, of thought, or of emotion, a certain definite molecular condition is set up in the brain; that this relation of physics to consciousness is invariable, so that, given the state of the brain, the corresponding thought or feeling might be inferred; or given the thought or feeling, the corresponding state of the brain might be inferred. But granted that a definite thought and a definite molecular action in the brain occur simultaneously, we do not possess the intellectual organ, nor apparently any rudiment of the organ, which would enable us to pass by a process of reasoning from the one phenomenon to the other. They appear together, but we do not know why. Were our minds and senses so expanded, strengthened, and illuminated as to enable us to see and feel the very molecules of the brain; were we capable of following all their motions, all their groupings, all their electric discharges, if such there be; and were we intimately acquainted with the corresponding states of thought and feeling, we should be as far as ever from the solution of the problem, "How are these physical processes connected with the facts of consciousness?" The chasm between the two classes of phenomena would still remain intellectually impassable. The speaker concluded this address in the following eloquent words:—

"In affirming that the growth of the body is mechanical, and that thought, as exercised by us, has its correlative in the physics of the brain, I think the position of the 'Materialist' is stated as far as that position is a tenable one. I think the materialist will be able finally to maintain this position against all attacks; but I do not think, as the human mind is at present constituted, that he can pass beyond it. I do not think he is entitled to say that his molecular groupings and his molecular motions explain everything. In reality they explain nothing. The utmost he can affirm is the association of two classes of phenomena, of whose real bond of union he is in absolute ignorance. The problem of the connection of body and soul is as insoluble in its modern form as it was in the pre-scientific ages. Phosphorus is known to enter into the composition of the human brain, and a courageous writer has exclaimed, in his trenchant German, "Ohne Phosphor kein Gedanke." That may or may not be the case; but even if we knew it to be the case, the knowledge would not lighten our darkness. On both sides of the zone here assigned to the materialist he is equally helpless. If you ask him whence is this 'matter' of which we have been discoursing, who or what divided it into molecules, who or what impressed upon them this necessity of running into organic forms, he has no answer. Science also is mute in reply to these questions. But if the materialist is confounded and science rendered dumb, who else is entitled to answer? To whom has the secret been revealed? Let us lower our heads and acknowledge our ignorance one and all. Perhaps the mystery may resolve itself into knowledge at some future day. The process of things upon this earth has been one of amelioration. It is a long way from the Iguanodon and his contemporaries, to the President and Members of the British Association. And whether we regard the improvement from the scientific or from the theological point of view, as the result of progressive development, or as the result of successive exhibitions of creative energy, neither view entitles us to assume that man's present faculties end the series,—that the process of amelioration stops at him. A time may therefore come when this ultra-scientific region by which we are now enfolded may offer itself to terrestrial, if not to human investigation. Two-thirds of the rays emitted by the sun fail to arouse in the eye the sense of vision. The rays exist, but the visual organ requisite for their translation into light does not exist. And so from this region of darkness and mystery which surrounds us, rays may now be darting which require but the development of the proper intellectual organs to translate them into knowledge as far surpassing ours as ours does that of the wallowing reptiles which once held possession of this planet. Meanwhile the mystery is not without its uses. It certainly may be made a power in the human soul; but it is a power which has feeling, not knowledge, for its base. It may be, and will be, and we hope is turned to account, both in steadying and strengthening the intellect, and in rescuing man from that littleness to which, in the struggle for existence, or for precedence in the world, he is continually prone."

The papers brought before the Section were very numerous, and we shall follow the plan adopted on former occasions of confining our notices to those which appear of general interest. The first read was the "Report of the Lunar Committee," in which the Chairman, Mr. Glaisher, referred to the progress which had been made in mapping the surface of the moon. No less than thirty-three gentlemen are engaged either in systematically observing certain zones in accordance with instructions issued by the Committee, or in examining particular objects at its request, the instruments employed varying from 3 inches to 22 inches in aperture. Instances of *difference* between former delineations and the present state of the moon's surface are increasing, and although no decided instance of change has been detected, the greater the number of differences the nearer we approach the discovery of change. Let but one *undisputed* instance of physical change be fully established, and selenography acquires from that moment a new aspect. The study of the moon's surface will then no longer consist in recording features that are unalterable, or in seeking to explain differences of aspect by varying angles of illumination and changes dependent upon libration. It will at once take a standing at least equal to those branches of astronomy which have been of late years particularly fruitful in discovery.

The Report entered somewhat largely into the question of change on the moon's surface, which is still undecided. The uncertainty as to the accuracy of former delineations and records combined with the extraordinary changes which some objects undergo—changes not altogether new, as they have been observed previously by Schrötter—render it very difficult to decide as to whether any real change has taken place.

This Report was followed by two papers on an allied subject *viz.* by Baron Von Mädler "On Changes of the Moon's Surface;" and, W. R. Birt, Esq., "On the Extent of Evidence of Change on the Moon's Surface." Father Secchi then gave an elaborate account of his "Researches on Spectral Analysis of the Stars." Mr. W. F. Barrett gave two papers "On the Passage of Radiant Heat through Liquids," and "On a Simple Method of Exhibiting the Combination of Rectangular Vibrations."

On Friday the 21st, the first paper read was "On a Further Development of the Dynamo-Magneto-Electric Machine," by W. Ladd. In this machine the continuity of the electric current depends upon the armatures revolving with a rapidity of from 1,800 to 2,000 revolutions per minute; but as the armatures have to be magnetized and demagnetized twice during each revolution, there would be in the latter case 4,000 flashes of light per minute. Now, it has been shown that every time iron becomes magnetized it is elongated, and again shortened when demagnetized. At every alteration, therefore, of the condition of the iron some small amount of heat must be devolved, and would increase to such an extent that, if unchecked, it would in course of time be so great as to destroy the insulation of the wire. To obviate this Mr. Ladd has perforated the two poles of the electro-magnet as close as possible to the armatures, and a stream of cold water circulates twice round the machine. This carries off the heat in a most effective manner, and no appreciable detriment in its electrical results occurs.

In the discussion which followed, Mr. Ladd said he wished to make a remark or two about the heating of the armature. He did not wish it to be inferred that the sole cause of heat was the elongation of the iron. Doubtless the electric currents passing through the wire would produce heat; but he believed that the quantity of heat produced by that means was small as compared with that produced by the elongation of the iron itself. He entertained this opinion for the following reason. He had lately applied one of these magneto-machines, driven by steam-power, in connection with a large inductorium, giving about 18-inch sparks; and after a few hours' work it had been found that the copper or primary wire surrounding the core of the coil appeared to be quite cool, while the iron core itself was considerably heated. He therefore mainly assigned the production of the heat to the cause he had specified.

Colonel Strange next read a paper "On the Necessity for State Intervention to secure the Progress of Physical Science." The author stated that knowledge, of whatever kind, was promoted principally in three ways, *viz.* by teaching, by education, and by exhibition. Unless the young were instructed, unless the workers advanced beyond what they learned when young, and unless the world was reminded of what had been done, and of what remained to be achieved, knowledge must languish. The provision, such as it was, which had been made in England to meet these three main requirements, had grown up casually with the progress of society, and was not equally complete in all branches of knowledge. The period is gone by when science generally can be cultivated with simple and primitive means; and the required researches of the present day need for their successful prosecution buildings expressly constructed for the purpose, extensive and costly appliances, and the continuous employment of the highest skill. It is evident that these requirements cannot be met by private enterprise and munificence, and it follows of necessity that the resources of the State alone can adequately supply the existing want; and that unless these are so employed the progress of scientific knowledge and discovery must become slower and slower. Without entering into premature details, the paper proposes that there should be established a system of national institutions for the sole purpose of advancing science by practical research, quite apart from teaching it; that such institutions, provided with extensive appliances and skilled professors and operators, should be presided over by a governing body constituted with reference solely to the scientific eminence of its members; that this body should direct the labours of the executive into such fields as they may deem most worthy of being explored; and that they should also have the power of sanctioning experiments and investigations proposed by any person unconnected with them. The advantages which the nation derives from the results of science, cultivated even as it is at present, desultorily and inefficiently, would be enormously multiplied by the introduction of the principle of continuity in research, and by the employment of the highest skill and the most perfect appliances. Systematic investigation conducted in the comprehensive manner proposed must prove directly remunerative, whether applied to strictly State purposes, or whether utilized in the public works, the manufactures, and the general necessities of the nation.

A Committee was subsequently appointed to inquire into the best means of carrying out the object proposed by Colonel Strange.

The next paper was "On a new Correction to be applied to Observations made with Hadley's Sextant," by Mr. T. Dobson, B.A. It was explained that the sextant is rarely used, save to satisfy the practical requirements of nautical astronomy. One object of the paper was to show that the instrument might be safely employed in determining the angular distance of terrestrial as well as of celestial objects, by taking account of a certain correction which was here investigated.

A long paper "On Actinometry," by Mr. L. Bing, was then read. The instrument used in these researches consists mainly of a tube of non-actinic glass, with an arrangement to bring a strip of sensitive paper into contact with one side of the interior. This tube is placed in diffused light, with its open aperture towards the sky. Light entering the tube and falling upon the sensitive paper commences at once to blacken it, but its power of so blackening is, of course, only in the ratio of the quantity of light which enters, and which necessarily diminishes as it proceeds further into the tube. The following are the principles upon which this instrument is founded: 1st. That diffused light, on entering a tube at one end only, varies in intensity within the tube inversely as the square of the distances from the aperture where light enters. 2nd. That any number of tubes, whatever their magnitude, contain the same intensity of light if the ratios of their diameters to their lengths are equal, and if we absorb the light that may be reflected from their sides. A carefully-calculated scale is fixed inside the tube at the side where the sensitive paper is fixed, the divisions being marked by a portion of a faint standard tint. When the sensitive paper in the instrument has been exposed for (say) ten minutes, the upper portion is darkened, and the first two or three tinted marks on the scale look white in contrast with the darkened paper: as the darkening down the tube gradually becomes less, the sensitive paper and standard tint appear of the same colour, and below that the paper is seen to be white by contrast with the standard tint.

A paper "On the Value of the Hollow Prism in examining Absorption Spectra" was then read by Dr. J. H. Gladstone.—In the prismatic analysis of the light transmitted by coloured liquids or solutions, the author has suggested the use of a wedge-shaped trough, so as to produce a line of light that had traversed every thickness—from one that was almost opaque to one which was next to nothing, and therefore permitted the passage of every ray. He now insists on the value of this method, as giving a much fuller account of the absorption, and especially as enabling the observer to represent it in a characteristic diagram.

The last paper this day was "On a New Automatic Telegraphic Apparatus," by Professor C. Zenger.

On Saturday, the 22nd, the papers read before this Section were, with scarcely an exception, mathematical, and defy condensation.

On Monday several Reports of Committees and some meteorological papers were read. Professor Morren read a paper "On some Curious Reactions of Chloride of Silver when in presence of Chlorine." Moist chloride of silver recently prepared when enclosed in a glass tube with an aqueous solution of chlorine, gradually becomes blackened when exposed to light, silver being reduced and chlorine liberated. On the sealed tubes being placed in darkness, the liberated chlorine would re-combine with the silver, again forming white chloride of silver. This decomposition and recomposition might be effected indefinitely.

The proceedings on the last day on which this Section sat were opened by a description of "A Galvanometer for the Detection of small Electric Currents," by F. H. Varley, Esq. The author explained that the smaller the magnet used in a galvanometer, the greater would be the sensitiveness of the instrument. He employs two forms—both of which had been found to answer exceedingly well. The first consists in suspending, with a single filament of silk, a magnet made of the finest steel wire that can be obtained, and rendering its motion apparent by viewing it through a rectangular prism by means of a microscope, in the eye-piece of which is placed a small graduated scale, photographed on glass. The magnet appears to be a black bar bisecting the field of view; and, as the finest wire obtainable for this purpose appears as thick as a scaffold-pole when sufficiently magnified, it is obvious that the slightest motion of the magnet must be rendered conspicuous by the image moving to and fro over the graduated scale placed in the eye-piece. The second form is more sensitive than the first. A small magnet, made of flat steel, polished on one face, is suspended in the usual manner by a single filament of silk, and a small micro-photograph of a graduated scale is placed at such a distance from the reflecting surface that each of the photographed divisions shall equal two minutes of arc as nearly as possible. The image of the scale thus reflected is sent in a line with the optic axis of the microscope, and any deflection given to the magnet causes the photographed scale to appear to move across the field of view. The reflecting surface moving doubles the apparent motion, giving the amount due to the angle of incidence, plus that of reflection. A movement of one graduated division being produced by one minute of deflection, if magnified 60 times by the microscope, will render a motion equal to one second of arc apparent.

The Hon. J. W. Strutt then read a paper "On a Permanent Deflection of the Galvanometer-needle by a rapid Series of equal and opposite Induced Currents." This paper contained a short notice of some experiments which led to rather unexpected results, of which the author could find no notice in the methodical treatises on electricity, although they might seem to lie in the way of any experimenter on induced currents. Two thick copper wires were coiled together, the circuit of one being completed by the battery and make-and-break apparatus, and that of the other by an ordinary astatic galvanometer of moderate sensitiveness. When the handle of the instrument is turned there are generated in the second circuit a series of instantaneous currents, which are alternately opposite in sign, but whose magnitudes are equal, although that corresponding to the break of the battery circuit is the most condensed. When, then, the instrument is worked with such rapidity that the interval between the currents is very small, in comparison to the time of free oscillation of the needle, the needles might be expected to be sensibly unaffected. But so far was this from being the case, that, although the swing of the needle produced by a single impulse was only a few degrees, yet under the influence of the series of equal and opposite currents it remained steadily at 60 or 70, and that on either side of the zero point, which had, in fact, become a position of unstable equilibrium.

CHEMICAL SCIENCE. (Section B.)

This Section is generally the least interesting to the general public, and is the most scantily attended. The papers brought forward were chiefly of interest to chemists only, and in the following abstracts we shall only notice the most important.

The President, Dr. Frankland, F.R.S., in his introductory address, delivered on August 20th, drew attention to the discouraging way in which scientific studies are being introduced into our older universities, the lack of the necessary funds for the proper endowment of professorships and for the provision of suitable buildings and apparatus in our modern institutions, and the insignificance of the rewards offered to successful students in science, which have naturally operated most injuriously upon the extension of chemical culture. Whilst in Heidelberg, Zürich, Bonn, Berlin, Leipzig, and Carlsruhe magnificent edifices have been raised, replete with all the newest contrivances for facilitating the prosecution of chemical studies, we are here still compelled to give instruction and conduct research in small and inconvenient buildings utterly inadequate to the requirements of modern chemistry. The large sums spent by the governments of Germany and Switzerland upon these establishments sufficiently testify to their opinion of the national value of chemistry in education. The laboratory at Zürich cost 14,000*l.*, that of Bonn 18,450*l.*, the one now nearly completed in Leipzig will cost 12,120*l.*, whilst the estimates for the Berlin laboratory, with its 74 rooms, amount to no less than 47,715*l.*

Dr. Phipson sent a note "On Sulphocyanide of Ammonium," a substance which he says exists in somewhat large quantities in commercial sulphate of ammonia, sometimes to the extent of 75 per cent. One of the most remarkable properties of this salt is its property of producing intense cold when dissolved in water; 500 grammes mixed with a litre of boiling water, reduced the temperature to near the freezing point in a few seconds.

Professor Abel, F.R.S., sent "An Account of the Great Cannon of Mohammed II., recently presented by the Sultan Aziz Khan to the British Government." The date of its casting is 1464. It has been applied to defensive purposes for four centuries. The composition was found to vary between copper 89·58, tin 10·15 per cent., and copper 95·20, tin 4·71 per cent.

Mr. Spiller gave "An Analysis of the Ancient Roman Mortar of the Castrum of Burgh, Suffolk." He finds, contrary to the generally received opinion, that the hydrate of lime becomes entirely recarbonated in course of time, and that the silica and lime have not united with each other in the long interval of fifteen centuries.

Dr. Matthiessen and S. P. Szczepanowski sent in "A Report on the Chemical Nature of Cast-iron." Although they have made seventy series of experiments, they have not been able to prepare iron free from sulphur. They are still prosecuting their search for a method of preparing pure iron.

Dr. Frankland, F.R.S., read a paper "On the Combustion of Gases under Pressure." The author finds that the increase of illuminating power is exactly in proportion to the increase of pressure. One of the most interesting experiments shown was that of sending an electric spark first through air under ordinary pressure, and then through air under doubled pressure. The result was, that the light of the spark due to ignition of the air was very much increased. The spark was sent also through many other gaseous and vapourized substances, showing most conclusively that the greater the density of the bodies the greater was the luminosity of their flames when submitted to ignition by the electric spark.

Dr. R. Angus Smith, F.R.S., made a verbal statement of the result of some experiments he had been conducting "On the Absorption of Gases by Charcoal." He finds that the gases are absorbed in whole volumes, or in volumes which are multiples of hydrogen. The following are some of the most curious and important results:—hydrogen 1, oxygen 7·99, carbonic acid 22·05.

GEOLOGY. (Section C.)

The Geological Section was presided over by Mr. Godwin-Austen, who opened its proceedings with an elaborate address. He remarked that some of the later stages of the earth's geological history were so abundantly illustrated in East Anglia, there had been so many labourers in the field, and there remained so many unsolved points, that he hoped the section would make local geology a prominent topic. The points alluded to belonged to the great Kainozoic period, and it was in East Anglia alone that the complete sequence of change, as it happened in this country, could be followed out.

The Crag-sea waters were expelled from the North Sea area by the rise of the land on the south, the elevation decreasing from Belgium to Norwich. The geologist found but little to guide him as to the details of the chronology of that vast period when the North Sea area was terrestrial and part of the general European land-surface. A long list of animals, from the Norfolk Mastodon to the Mammoth, had left their remains there, and some of them ranged over Central and Southern Europe; but how many of them co-existed remained undecided.

The "forest-bed" of Cromer gave a glimpse of the vegetation of the period—including the Norway spruce, Scotch fir, yew, and oak—but it was more than probable that it must be taken only as the facies of the flora of the last stage of terrestrial conditions prior to the next great physical change.

Just as the Crag-beds came in as breaks in the lapse of Tertiary terrestrial conditions, so did the accumulations of the great northern submergence as a second intercalation; but the physical change was greater and of a different order. The Arctic basin extended itself as low as to lat. 50° N., by a slow submergence from north to south.

Again the northern hemisphere emerged, apparently from south northward, till England as a whole had the same general arrangement of land and sea as in the Crag period.

Over the whole of the European and American areas there was a region of broad expanses of water-worn detritus, often placed at considerable elevations above the present water-levels, the superficial extent of which had caused them to be identified with the members of the "Glacial drift," peculiar to another area, and from which they were quite distinct. The conditions indicated were those of low winter temperature, terrestrial surfaces with alluvial and fluviatile accumulations, indicative of torrential and periodic rivers. They lay south of a line drawn across Europe, occasionally on one side or the other of the 51st parallel, and they were derived from the areas to which belonged the existing river-systems of the South and Mid-European continent.

North of this line the detrital accumulations were neither local as to composition, nor had they much reference to surface configuration. Their distribution showed that the expanse of water was continuous and marine. This Drift formation covered the whole of Norfolk, and afforded evidence of submergence to the extent of 600 feet and upwards. It might be accepted as certain that subaërial glaciation had long been at work prior to the submergence. The change of relative level was gradual, proceeded from north to south, and was greatest in the former direction.

Several "Reports" were laid before the Section. One of these was the "Fourth on the Fossil Crustacea," by Mr. H. Woodward, who stated that he had recently received from the Carboniferous shales of Carluke, specimens of a new form of crustacean allied to *Cyclus*, and that he had been enabled to add two new species of a family not hitherto known in a fossil state in Britain. They belonged to the genus *Callianassa*, and were found, one in the Greensand near Belfast, the other in the Eocene beds of Hempstead, in the Isle of Wight.

Dr. Duncan's "First Report on British Fossil Corals" dealt with the relations of Fossil Corals to those now living. It was followed by a paper, from the same author, on a new species of coral belonging to the genus *Clisiophyllum*, from the Scotch Coal-field.

A paper by Mr. Lobley "On the Range and Distribution of the British Fossil Brachispoda," showed, by the aid of diagrammatic tables, the number of species belonging to each genus and family, as well as to the class, found in the different systems of rock-formations and their principal divisions.

Dr. Otto Torell, of Lund, in Sweden, in illustration of his very important paper "On some New Fossils from the Longmynd Rocks of Sweden," exhibited a series of slabs marked by the impressions of various land plants, known to geologists as *Chondrites*. The rocks from which they were taken were of an age similar to those of the Longmynd rocks of Britain, and the author held that they had been deposited in shallow water. Sir C. Lyell said he looked on the specimens with the greatest interest as remains of the earliest land plants yet known, and he confirmed the author's determination of the age of the deposit. Mr. Carruthers stated that the only vegetable markings which had hitherto been found in Silurian rocks were produced by plants occupying the lowest position in the vegetable kingdom; but here, much lower geologically, were plants of a very much higher grade. They had all the characters of true monocotyledons, and very nearly resembled the common flag of the garden and river.

Mr. H. Hicks, in a paper "On Recent Discoveries of Fossils in Cambrian Rocks," stated that he had found in Lower Cambrian strata no fewer than ten genera of Brachiopods, Pteropods, and Phyllopods.

In a paper "On the Fossil Fishes of Cornwall," Mr. Peach reminded the Section that in 1841 he stated that he had found fish-remains in the Devonian slates near Fowey; that in 1843 he produced much finer specimens, which were acknowledged by all to be true ichthyolites until, in 1855, Professor M'Coy pronounced them merely sponges; that he had unwaveringly believed in their ichthyic character; and that early in the present year (1868) they had been again, and by the highest authorities, stated to be unmistakable fish.

Mr. C. Moore, in his paper "On the Fossil Contents of Mineral Veins in the Carboniferous Limestone," stated that out of 134 samples from the mines of Cumberland and Yorkshire, 80 had yielded organic remains more or less abundantly, including *Valvata* and other fresh-water shells, often in great abundance. He had also found teeth and scales of fish. *Foraminifera* were very rare, whilst *Entomostraca* and *Crinoidea* were prevalent.

Mr. J. Thomson read a paper on "Certain Reptilian Remains found in the Coal-measures of Lanarkshire." The fossils were Batrachian, and found in a stratum between ironstone and coal. They were associated with remains of fish believed to be peculiar to the Coal-measures.

Dr. Mann, in his communication "On the Coal-field of Natal," stated that the Natal coal occurred in seams from 2 to 6 feet thick; that, from experiments, it was found to give a pure gas, a higher percentage of coke than the best English coal, and when burnt in a furnace it had but little tendency to form clinkers; that under easy steam it was better than the Welsh coal; that it gave the steam more quickly, but that when steam was got up the Welsh coal gave more work out of the same amount of coal.

Mr. H. Clarke read a paper "On the Western Asia Minor Coal and Iron Basin," in which he pointed out the European extension of the deposit by way of Constantinople. This coal has not been worked, although covering so large an area.

A paper "On the Classification of the Secondary Strata" was read by Mr. H. G. Seeley, who remarked that from the denudation of cliffs, deposits near the shore would be shingle or conglomerates, then sand and clay, and still further seaward limestone. Supposing a depression of the area to take place, the conglomerates would be overlaid with sand and clay, and, should the depression be continued, eventually with limestone. With an upheaval, the reverse of this would occur.

The same author read a memoir "On the Relations between

Extinct and Living Reptiles." Having described the general characters and the classification of the Reptilia, he showed that the Pterodactyles stood at the head of the class, being more highly organized than any other reptiles, living or extinct. He wished it to be understood, not that they were birds, but that they possessed ornithic affinities.

In his paper "On the Skull and Bones of Iguanodon," the Rev. W. Fox detailed at some length the anatomical structure of the teeth and bones, and expressed his belief that the skull recently discovered in the Isle of Wight belonged to a new species.

The aim of Mr. Jeck's paper "On the Ferruginous Sandstone of the Lower Oolite near Northampton," was to make the following suggestion respecting its mode of formation:—that large rivers carried sand and mud and a solution of iron into a large estuary; that after some time subsidence carried the area into deep water, where shells characteristic of such conditions were deposited; that this was succeeded by upheaval, when shallow-water shells and ferruginous matters were accumulated, and that finally the whole was covered with sand.

M. Coquand's paper "On the Cretaceous Strata of England and the North of France, compared with those of the West, South-west, and South of France, and North Africa," contained a detailed account of the characters and fossils of the deposits in the localities named, and referred to their differences at some length.

Mr. Rose read a communication "On the Thickness of the Chalk in Norfolk," as indicated by well borings in various parts of the county.

A contribution by Mr. H. M. Jenkins, "On the Tertiary Deposits of Victoria," contained a careful description of the strata in various localities, and especially on the coast south-west of Port Philip. It may be stated generally that the Tertiary deposits were accumulated in a trough in Mesozoic beds, that they were afterwards contorted and denuded, and that the trough, now deeper and probably narrower, was refilled with Post-pliocene standstone. The Tertiary fossils were corals, echinoderms, and innumerable species of shells and polyzoa.

The suggestion of the President met with a full response in a large number of papers on local geology, which showed that East Anglia contains many unsolved problems. Amongst these communications were those by the Rev. O. Fisher "On the Denudations of West Norfolk," Messrs. Wood and Harmer "On the Glacial Structure of Norfolk and Suffolk," Mr. G. Maw "On the Sequence of Deposits in Norfolk and Suffolk," Mr. J. E. Taylor "On the Norwich Crags and their relation to the Mammaliferous Beds," Mr. A. Bell "On the Molluscan Fauna of the Red Crag," Mr. Rose "On the Crag at Aldeby, in Suffolk," the Rev. J. Gunn "On the Alternate Elevations and Subsidings of the Land, and the order of Succession of the Strata in Suffolk and Norfolk," Dr. Crisp "On the Skeleton of a Fossil Whale recently found on the East Coast of Suffolk," Mr. E. R. Lankester "On the Oldest Beds of the Crag," Dr. J. Lowe "On the Carstone of West Norfolk," and Mr. Evans "On some Cavities in the Gravel of the Valley of the Little Ouse."

Mr. Fisher stated that immediately upon the Chalk at Thorpe, where the Crag rested upon it, was a thick bed of angular flints, apparently the accumulated result of the removal of the Chalk intervening between several layers. Amongst the flints numerous bones, teeth, and tusks of Mastodon, *Elephas meridionalis*, and other mammalia occurred. He inclined to the view that the Chillesford Clay was below the "Forest-bed." At any rate the sequence of events introduced the deposition upon the Crag of a fine clay, probably formed in an estuary open to the Northern Ocean, and to which whales had access. This was in all probability the estuary of the Rhine, and of the Thames and other tributaries. Its sides became dry land so as to allow of the growth of the forest upon the old muddy bottom. This condition lasted for a long period, and synchronized with a climate warmer than that which preceded or followed it. As the land continued to sink, the "Laminated series" accumulated and extended westward. The "Lower Boulder Clay" overlaid the Laminated beds, but during the interval between them the sea must have been much deeper, and involved in a system of extensive tidal currents. After glancing at the evidence of iceberg-action towards the close of the "Lower drift," the author spoke of the "Middle drift," when large masses of chalk were dropped amongst the sand and mud in the deepening sea.

According to Mr. Maw, the whole of the beds above the "Red Crag" in the well-known Chillesford Crag-pit pertained to the "Chillesford Clay" series. This Red Crag was not the equivalent of the "Norwich Crag;" the upper part of the Chillesford beds probably graduated into the Drift underlying the Boulder Clay of High Suffolk. These were considerably older than the coast-beds of Cromer, including the Forest bed, the Laminated beds, and the overlying Boulder Till, and contorted Drift.

Mr. Taylor held that the whole of the "Mammaliferous bed" between the Chalk and Crag was quite distinct from the true Crag, and formed under more distinctly marked marine conditions. The abundance of northern shells in the upper beds as compared with the lower proved the increasing cold. The succeeding "Glacial series" was a result to which a study of the various Crags necessarily led.

Mr. Bell, having found many double bivalves in excellent condition in the deposit between Sutton and Waddingfield, could not accept the hypotheses that the Red Crag sea had been very turbulent, and that the fossils were largely derivative.

Mr. Rose expressed the opinion, based on an extensive series of careful investigations, that the Aldeby Crag belonged to the "Norwich Crag."

Mr. Gunn regarded the German Ocean as having been the vast trough into which many tributary rivers poured their waters on the right and left, but closed by chalk hills on the south so as to afford a communication between this country and the Continent, and a way for the mastodon, elephant, and other mammals to traverse. The soil of the forest bed was upheaved to the surface, and the forest grew upon it. A great change in the fauna took place,—different species of elephants and deer being introduced. Having remained stationary a long time, the land at length gradually subsided, and the laminated beds were formed: first, fresh-water beds; then, brackish beds; next, marine beds, including the Mammaliferous Crag and the Chillesford clays and sands, with shells of an increasingly arctic character.

The whale described by Dr. Crisp was 31 feet long, and found in the Chillesford Clay.

Mr. Lankester believed the bed to which he called attention, and which occurred in Suffolk, to have been derived from a deposit somewhere near at hand, and about the age of the Diestien, or Black Crag of Belgium. It contained remains of mastodon, rhinoceros, tapir, and whale.

Dr. Lowe described a series of perforations from a quarter of an inch to an inch in diameter, formed by some boring animal, in a sandstone deposit near Lynn. Each perforation commonly contained a nodule, which the author ascribed to the presence of the remains of the borer.

Mr. Evans gave reasons for believing that the cavities which he described, after a careful personal inspection of them, were connected with the well-known "pipes" in the chalk, and which had been formed by the agency of water containing carbonic acid; and that, contrary to the general rule, some of the overlying gravel beds, instead of subsiding into the hollow thus made, were sufficiently tenacious to remain intact. Some of the cavities were "large enough to hold a cart."

The Committee for exploring Kent's Cavern, Devonshire, presented their Fourth Report. The general results were similar to those stated in the previous Reports. The chief new feature was one of considerable interest and importance, being the discovery of a floor of stalagmite overlying a thick detrital accumulation, both of them older than those previously found: thus, in one branch of the cave there were in the same vertical section: first, or uppermost, the thick floor of stalagmite, which had been followed in unbroken continuity from the external entrances, and had yielded remains of extinct animals; second, the common red earth, replete with remnants of the ordinary extinct cave fauna, and containing flint implements; third, an older floor of stalagmite, very thick and crystalline; and, fourth, or lowest known, an extremely tough hard breccia, crowded with unbroken, ungnawed, unrolled bones, almost all of which were ursine, and lay together without reference to their anatomical relations.

Mr. Pengelly, in a paper "On the Conditions of some of the Bones found in Kent's Cavern," described a series of experiments which, as he held, showed that the "split bones" had not been divided by the spelæan carnivores, or by exposure to the weather, but that they could have been, and indeed were, split by Palæolithic man for the purpose of obtaining material for bone tools.

In his paper "On New Discoveries connected with Quaternary Deposits," Mr. C. Moore stated that he had found remains of mammals, extinct in this country, in Oolitic fissures, from the Cotswold to the lower part of Somersetshire. In a quarry near Frome, where the subject first caught his attention, the workmen had found, and unfortunately destroyed, a series of hut circles, said to have been unusually perfect, cut out of the solid rock, retaining indications of fire, and having steps connected with them. These, he believed, were older than the fissures, and carried back considerably the antiquity of man.

The Rev. J. Brodie, in a communication "On Geological Changes that have taken place on the Coast of Britain in recent Times," endeavoured to show that the last change of level in Scotland was an upheaval of about 30 feet, and was not more recent than a few centuries before the Christian era.

Mr. Grove read a paper "On Artificial Rocking Stones," in which, after describing the great rocking stones of Cornwall, he explained a set of ingenious experiments which he had made in order to show that the celebrated *logans* of the South-western Counties were purely natural. The results, which were exhibited, were examined with much interest.

Interesting papers were read by Mr. Rose "On the Conchoidal Fracture of Flints, as seen in old Buildings in Norwich;" Professor Tennant and Rev. C. Nicolay "On the Discovery of Diamonds in Cape Colony and Brazil;" and Mr. S. Sharp "On a Remarkable Incrustation."

We regret that we cannot do more than mention the Reports by Mr. E. Whymper "On the Fossil Plants of Greenland," and by Mr. W. S. Mitchell "On the Leaf-beds of the Lower Bagshot Series of Hampshire."

BIOLOGY. Section (D.)

This section formed itself into a department of Zoology and Botany and a department of Anatomy and Physiology, as on previous occasions. The Rev. M. J. Berkeley, the distinguished writer on Cryptogamic Botany, was President of the Section, and sat in the department of Zoology and Botany, where also the other botanists, among them Dr. Hooker, Professors Balfour, Dickson, Lawson, and Perceval Wright, and the general zoologists congregated. Mr. Flower, F.R.S., of the Royal College of Surgeons' Museum, presided in the other department, and was supported by many anatomists and doctors; amongst them were Professor Rolleston, Dr. Hughes Bennett, Dr. Benjamin Richardson, Professor Humphrey, Professor Huxley, and also the distinguished continental physiologists, Heynsius, Paul Broca, and Béhier.

Mr. Berkeley opened the proceedings of the Section with a remarkably interesting address. He directed his remarks, first, to recent researches and speculations in Cryptogamic Botany, on which he is so well qualified to speak judicially, and then to the theory of Pangenesis. He alluded to the observations of De Bary and Cienkowski on organisms which appear to be intermediate between plants and animals, such as Myxomycetes and some forms of Monads, and confirmed the deductions which they drew from their observations. He then noticed Hallier's views as to the fungoid origin of certain diseases. At first Hallier had merely observed fungi in Asiatic cholera, but recently he had stated that in typhus, typhoid, and measles (in the blood), in variola and in vaccinia (in the exanthemes), he had found certain minute organisms which he termed Micrococci, which, when cultivated in the way known to students of moulds, &c., produced each a constant and characteristic fungus. He did not consider that Hallier had proved his case; his experiments were far from conclusive, and he drew conclusions hastily. It was quite possible that certain fungi might occur constantly in substances of a certain chemical and molecular constitution, but this might be a case of effect instead of cause. The matter had been taken up by De Bary and our own Army Medical Department, some of whose able officers had been commissioned to investigate the question fully.

The recent researches of Mr. Herbert Spencer had shown, by the introduction of coloured fluids into the tissues of the living plant, that the sap not only ascends by the vascular tissue of plants, but that the same tissue returns and distributes the sap after it has been modified in the leaves.

After making some observations on the morphology of leaves, and on the subject of free-cell formation, the President referred to Darwin's theory of Pangenesis. Others, he said, as Owen and Herbert Spencer, had broached something of the kind, but not to such an extent, for Darwin's theory included Atavism, Reversion, and Inheritance, and embraced mental peculiarities as well as physical. The whole matter was at once so complicated, and the theory so startling, that the mind at first naturally shrank from the reception of so bold a statement. Like everything, however, which came from the pen of a writer whom he had no hesitation, as far as his judgment went, in regarding as by far the greatest observer of the age, whatever might be thought of his theories when carried out to their extreme results, the subject demanded a careful and impartial consideration. Like the doctrine of natural selection, it was sure to modify more or less their modes of thought. Even supposing the theory unsound, it was to be observed, as Whewell remarked, as quoted by their author, "Hypotheses may often be of service to science when they involve a certain portion of incompleteness and even of error." Mr. Darwin said himself that he had not made histology an especial branch of study, and he (Mr. Berkeley) had, therefore, less hesitation in expressing an individual opinion that he had laid too much stress on free-cell formation, which was rather the exception than the rule. Assuming the general truth of the theory that molecules endowed with certain attributes were cast off by the component cells, of such infinitesimal minuteness as to be capable of circulating with the fluids, and in the end to be present in the unimpregnated embryo cell and spermatozoid, capable either of lying dormant and inactive for a time, or, when present in sufficient potency, of producing certain definite effects,—it seemed far more probable that they should be capable, under favourable circumstances, of exercising an influence analogous to that which is exercised by the contents of the pollen tube or spermatozoid on the embryo sac, than that these particles should be themselves developed into cells; and under some such modification the theory was far more likely to meet with anything like a general acceptation. Be this as it might, its comprehensiveness would still remain the same. They must still take it as a compendium of an enormous mass of facts, comprised in the most marvellous manner within an extremely narrow compass. In conclusion, he said it was obvious how open such a theory was to the charge of materialism. It was an undoubted fact, however, that mental peculiarities and endowments, together with mere habits, were handed down and subject to the same laws of reversion, atavism, and inheritance, as mere structural accidents, and there must be some reason for one class of facts as well as the other, and whatever the explanation might be, the hand of God was equally visible and equally essential in all. They could not now refer every indication of thought and reasoning beyond the pale of humanity to blind instinct, as was once the fashion, from a fear of the inferences which might be made. Should any one, however, be still afraid of any theory like that before them, he would suggest that Man was represented in Scripture as differing from the other members of the animal world by possessing a Spirit as well as a reasoning Mind. The distinction between *psyche* and *pneuma*, which was recognized by the Germans in their familiar words *seele* and *geist*, but which we had no words in our own language to express properly,—or, in other terms, between mere mental powers, which the rest of the creation possessed in greater or less degree in common with mankind, and an immortal spirit,—if rightly weighed, would, perhaps, lead some to look upon the matter with less fear and prejudice. Nothing could be more unfair and unwise than to stamp at once this and cognate speculations with the charge of irreligion. Of this, however, he felt assured, that the members of the Association would unite with him in bidding its great and conscientious author God speed, and join in expressing a hope that his health might be preserved, to enrich science with the results of his great powers of mind and unwearied observation.

Of Zoological papers, we must notice first Mr. Gwyn Jeffreys' "Dredging Report." It is a matter for much regret that the smaller income of the Association this year has rendered it necessary to withhold any further large grants for dredging at present. This year Mr. Jeffreys dredged off the Shetlands, having very bad weather; he, however, made some interesting discoveries. In this report he summarized the results of five years' dredging on these coasts. As a rule, he found that the mollusca of northern seas were much larger than the same species occurring in southern seas. He did not consider that the various zones of depth usually adopted by naturalists were of any real value. Two, he considered, were sufficient besides the abyssal or marine, namely, the littoral and the submarine. The various animals dredged other than mollusca had been entrusted to other naturalists for examination, and their reports in previous years showed how many new and interesting forms had been thus added to science.

In a paper "On Shetland Sponges," the Rev. A. M. Norman described and exhibited a vast number of the forms of Sponges dredged by Mr. Jeffreys. One of these was especially interesting from its peculiar form and history. Three years since when dredging off Shetland, they had brought up long tube-like bits of sponge which Dr. Bowerbank described as a new species, thinking that the specimens were perfect; but this year Mr. Jeffreys had dredged up great spherical sponges with these little tubes standing out from them, and they were thus seen to be quite different to what was at first supposed. The spherical sponges were bigger than one's fist, and when opened were found to be filled with jelly-like sarcode, which could be poured out. This was quite an unprecedented structure, and, in fact, was only paralleled by the great hollow sponges found in the chalk formation. Mr. Norman called this new sponge *Oceanapia*, or Sea Turnip. In another paper, Mr. Norman described a sponge which had been thought by the Scandinavian naturalist, Lovén, to be like the celebrated Glass-rope Sponge of Japan. Mr. Norman, however, showed that there was an essential difference in their structure, and described some other sponges which had an *external* resemblance of form only to Lovén's supposed boreal Hyalonema.

"On some Organisms living at a Depth of 15,000 feet in the North Atlantic," was the title of a paper read by Professor Huxley. In 1859, specimens of the deep-sea soundings, obtained by Captain Drayton in the North Atlantic, had been submitted to Professor Huxley for examination, and he had then reported to the Government on the microscopic organisms contained therein. Besides the Foraminifers (*Globigerinæ*), he had discovered little bodies which he called Coccoliths. Mr. Sorby had since discovered these little Coccoliths in the chalk, together with the Globigerinæ, which made it so much like the Atlantic mud. In 1862, Dr. Wallich redescribed the Atlantic Coccoliths, and also bodies which he called Coccospheres, and from the breaking up of which he believed the Coccoliths to arise. Professor Huxley had now re-examined his specimens with a much better object-glass than he used previously, namely a $\frac{1}{12}$th of Ross, and he had some new statements to make as to the Coccoliths. They have nothing to do with the Coccospheres. In the slimy ooze, which is dredged up from the Atlantic, soft gelatinous masses about the $\frac{1}{400}$th of an inch long occur, in which are scattered small masses of granules, and in which also are disposed little oval bodies of carbonate of lime, $\frac{1}{1000}$th of an inch long at most. These last are the Coccoliths; they are of two sorts, one more complex than the other. The gelatinous mass is considered by Professor Huxley to be formed by the running together of a number of separate organisms, each represented by a mass of granules, and having, when alive, its own pseudopodia. The Coccoliths are to these animals what the Spiculæ of Radiolaria, or Sponges, are to them. Professor Huxley could not say whether this organism was animal or vegetable. In answer to some remarks by Dr. Hughes Bennett, he stated that the facts recorded above do not confirm in the least the doctrine of Heterogenesis,—he wished they did. They only proved the existence of a vast sheet of organized matter at this great depth, which he suggestively had spoken of as "Urschleim."

In a very detailed communication "On the Boring of certain Annelids," Dr. McIntosh controverted the chemical theory of erosion suggested last year, at Dundee, by Mr. Lankester in reference to these animals. He exhibited specimens of shale which he asserted were not calcareous, nor subject to erosion by acids, and which were yet perforated by *Leucodore*. Mr. Ray Lankester in commenting on this paper, maintained that his inference from the evidence which had come before him last year, was at the time a just one.* The presence of an acid must be an important auxiliary in the erosion of limestone rocks, though loose shales could be bored mechanically. Dr. McIntosh's figures of the bristles of *Leucodore*, he showed, were erroneous.

Dr. McIntosh also gave a short account of the Annelids dredged by Mr. Gwyn Jeffreys in Shetland.

Among anatomical papers, that of Mr. Flower "On the Homologies and Notation of the Teeth of the Mammalia" was one of great importance. He had discovered that some of the so-called monophyodont mammals, namely the Armadilloes, had a complete set of milk teeth preceding those with which they were provided when adult; further he had shown, recently, that in marsupials only one tooth, the so-called fourth premolar, has a successor, whilst in dogs only one or two at most of the premolars have predecessors. In seals, the first set of teeth were extremely minute, mere points of tooth substance, and this led to the belief that they were evanescent. From these facts and others of a similar nature, Mr. Flower concluded that the so-called milk or first set of teeth is by no means to be regarded as the typical or chief series as Professor Owen had supposed, to which the second set are a super-addition; but on the contrary, the milk-teeth are something added to the normal dentition in the higher mammalia, and more especially in those groups which require teeth when young. In the discussion on this paper, in which Professors Huxley and Rolleston took part, an interesting question was raised as to whether the evanescent condition of the milk-series of teeth in the seals did or did not indicate an approach to the condition of the Cetacea, which have but one set, that is are Monophyodont.

Professor Rolleston, in a paper "On the Pectoral Muscles," gave his conclusions as to the homologies of the muscles of the upper arm and chest in Mammals, Birds, and Reptiles. He also discussed the serial homology of the muscles of the fore and hind limb, making use, in both cases, of the distribution of the nerves to the muscles as an index of homology.

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* See 'Quarterly Journal of Science,' October, 1867.

Dr. Edward Crisp drew attention to "Some Points in the Anatomy of the Gorilla," which led him to regard it as less anthropomorphous than the Chimpanzee; also to the "Intestinal Canal of the *Thylacinus*," which he stated was the shortest and simplest amongst either Mammals or Birds.

Professor Cleland answered the question, "Is the Eustachian tube open in the act of swallowing?" in the negative: Mr. Toynbee had held that it was open; but Dr. Cleland had had an opportunity of witnessing its closure during swallowing in a patient in whom ulceration had exposed the part to view.

Physiology was largely represented, if the number of papers may be held to furnish an index. Dr. Richardson read a "Report on the Physiological Action of the Methyl Series." The object of his researches during the year had been to bring into actual practice some of the substances, the physiological action of which he had ascertained, and on which he had previously reported; secondly, to examine more carefully the mode of action of those bodies of the series (anæsthetics) which produce sleep and insensibility to pain; thirdly, to investigate the action of some other bodies of the series previously unstudied; and fourthly, to test the antidotal influence of some of the substances against the action of certain alkaloidal poisons. Bichloride of Methylene had been introduced as an anæsthetic; nitrate of amyl was used to relieve the spasm of *angina pectoris*; and iodide of methyl promised to be useful in the cure of cancer. The iodides of ethyl and methyl and their nitrites had been found to be efficient antidotes to strychnia and nicotine in cases of poisoning, the difficulty was to properly apportion the dose. In one case, an animal experimented on had completely recovered.

Dr. Richardson also related experiments "On the Action of Extreme Cold on the Nervous Function," from which it appeared that frogs might be so far frozen as to become hard and stiff, and yet recover by slow thawing. The freezing of parts of the brain in birds had also given interesting results.

The same observer described an attempt at the transmission of light through animals whilst living, which did not appear a very hopeful method of obtaining knowledge of their structure.

Dr. Anstie read a most valuable paper "On the Influence of Alcohol on the Pulse," in which the importance of the use of the sphygmograph was shown. By its means Dr. Anstie had been able most clearly to diagnose cases of fever, &c., in which it was right, and others in which it was not right, to administer alcohol.

Three papers relating to the question of the existence of a special organ of language in the brain were read: one by Dr. Paul Broca, who was the first to point to the left third frontal convolution of the cerebrum as the seat of disease in cases of Aphasia; the second by Dr. Hughlings Jackson, who has studied most carefully and successfully the pathology of the brain; and the third by Mr. Dunn. Dr. Broca classified the various forms of loss of power of speech according to their causes, whether paralysis of the muscles, loss of general intelligence, or loss of the special power of the use of words. It was this last power, the loss of which is called Aphasia, for which he claimed a special organ in the left frontal convolutions. In the discussion many cases were brought forward by the various physicians present, which tended on the whole to show that the evidence for localizing the power of articulate speech or verbification in a particular frontal convolution was not sufficiently satisfactory. The subject is one which must still occupy the attention of physiologists, but the direction of opinion seems to be against M. Broca's theory.

The Edinburgh committee appointed to experiment and report on the "Influence of Mercury on the Secretion of the Bile," gave an account of their researches, being represented by Dr. Arthur Gamgee and Dr. Hughes Bennett. The experiments had been performed on dogs and were of the most careful and satisfactory character, so as to elicit the highest praise from all the members of the Section. Fistulæ had been made into the bile ducts, and thus the amount of bile secreted was observed. It was found from these researches to be in a normal condition much less than has been usually supposed, and it was definitely proved that the administration of small doses of mercury did not increase its flow. Dr. Gross of New York wished the experiments had been made on men, but was reminded that it was not possible to make fistulæ in human subjects at will, and that the action of the drug on the dog was in all other respects identical with the action on man, and hence warranted the conclusion that in the particular of bile-secretion the action was the same.

Dr. Thompson Dickson read an essay "On Vitality as a Mode of Motion," in which the old views of the correlation of the vital and physical forces were reiterated, the objectionable word vitality being, however, used, and the formative or plastic force of living matter being confused with the modes of motion of which it is the seat.

Botany was of course in full vigour at this meeting. Many papers on the occurrence of rare or new plants were read, as also some important ones on structural Botany.

Dr. Karl Koch gave an interesting sketch of his researches on

"The Origin of our Fruit Trees." He had travelled in Asia Minor and Persia for the purpose of investigating this question, and was led to conclude that the Apricot, and perhaps the Peach, had no wild representative in these countries, though perhaps they might have in China. The Prunes of our fruit-gardens were not derived from the common wild Plum of Europe, but from another stock which occurs wild in the East. Many gardeners and botanists hold that the Peach and Nectarine are merely varieties of the Almond, in which the green rind has become fleshy and sweet. Dr. Koch adduced facts in favour of this view, amongst others the production of almond-like fruits by a peach-tree through atavism, and the existence of an inferior form of peach-tree in gardens known as Peach-almonds. Such a plant Dr. Koch had found growing wild in many parts of Persia.

Mr. Moggridge described and exhibited specimens of the "Muffa," a remarkable cryptogamic growth which is found in the sulphurous springs of Valdieri, and which is used in the medicinal baths as an external application.

A most interesting paper relating to Ethnology, was that of Mr. E. B. Tylor "On Language and Mythology as Departments of Biological Science." The author pointed out, by examples, how definite laws of the development of the human mind might be traced by the examination of the rudest languages in different parts of the globe, and by the study of the origin of myths. We must, he said, look for laws of independent similar development in civilization, as in vegetable and animal structure, and the backward state in which the science of culture still remains, seems mainly due to the systematic methods so familiar to the naturalist having hitherto been so imperfectly worked.

Of practical matters, the importance of "Arboriculture" was again brought before the Section by Mr. Brown. Dr. Cleghorn also discussed the subject of "Forestry in India." Professor Alfred Newton, in a paper "On the Zoological Aspects of the Game Laws," urged the necessity of a "close time" being enforced by the Government in this country for all birds and other animals during which it should be illegal to carry a gun. Such a period was adopted both on the Continent and in America during the breeding season of birds, and was a very right measure; for at present in this country thousands of birds are shot when nesting, especially sea-gulls, and their young are allowed to perish of hunger. Professor Newton also deprecated the indiscriminate slaughter of what keepers are pleased to call vermin, which are really most useful animals in destroying smaller creatures, such as rats and mice, which do act injuriously by feeding on the eggs of game and other birds. Miss Lydia Becker, of Manchester, replied to Professor Newton's accusation against her sex. If Professors would instruct ladies on the habits of these birds, and let them know that the birds were killed when tending their young, no lady, she was sure, would wear the feathers in question. Several members spoke in support of the proposition for a "close season."

GEOGRAPHY AND ETHNOLOGY. (Section E.)

Under the able presidency of Captain Richards, R.N., F.R.S., hydrographer to the Admiralty, Section E met in St. Peter's Hall on four days,—Thursday, Friday, Monday, and Tuesday. Saturday was a *dies non*, owing to the excursions. Including the President's address, there were in all twenty-two communications made to the Section, and a large proportion of them were from persons who have attained much distinction as travellers or scientific geographers, or both. The meeting of 1868 was destitute of the personal interest which has attached to many former meetings of the British Association, more especially in the Geographical Section, on account of the decease of Mr. John Crawfurd, and of the absence through illness of Sir Roderick Murchison. Mr. Crawfurd, notwithstanding his great age,—he was an octogenarian at his death,—had of late years contributed so largely to the business of this Section, both by his papers and his remarks in the discussions, that for some years to come his familiar form and cheery voice will be missed by the members who take a special interest in the geographical proceedings of the Association. His old friend and associate, Sir Roderick Murchison, still survives him; but even he is so fast approaching octogenarianism that he cannot be expected to make much further active exertion in the business of the British Association.

The meetings of the geographers in St. Peter's Hall were not wholly destitute of "lions," for there were present two of the most distinguished of the Abyssinian captives, Dr. H. Blanc and Mr. Rassam. The subjects discussed in this Section were more exclusively geographical than has been the case at some former meetings. Those that partook more of an ethnological character were taken up in the International Congress of Pre-historic Archæology, the fourth annual meeting of which was held this year at Norwich, under the presidency of Sir John Lubbock, simultaneously with the thirty-eighth meeting of the British Association. Henceforth the term "Ethnology" will not be continued in the title of Section E, a resolution to that effect having been passed by the General Committee, in accordance with a recommendation from the Council of the Association. Section D (Biology) will probably, in subsequent years, as at Nottingham in 1866, undergo fission, so that there may be a department of Ethnology or Anthropology, as there is now a department of Physiology, while there is also one of Zoology and Botany.

Captain Richards, in his opening address, briefly reviewed the present state of geographical knowledge, adverting to those blanks on the surface of the earth which appeared to him to merit the labour and attention of future explorers, and dwelling briefly on the results which are certain to follow in the interests of science and the interests of humanity. He confined his attention to the present and the future rather than to the past. Amongst the dark spots on which the traveller and navigator have yet to throw light, Captain Richards referred specially to Africa, Australia, New Guinea, Borneo, and the Arctic regions. The fate of Dr. Livingstone, and Dr. Neumeyer's proposal for an organized exploration of the interior of Australia were both noticed, and regret was expressed that the desire on the part of a number of geographers for the prosecution of further polar search had not been reciprocated by the public and the Admiralty.

The Norwich meeting following close upon the successful result of the Abyssinian expedition, it was naturally expected that Abyssinian topics would bulk largely among the subjects of discussion. There were only two papers, however, on Abyssinia. One of these was "On the Physical Geography of Abyssinia," by Mr. Clements R. Markham (Secretary, Roy. Geog. Soc.), geographer to the recent expedition. The author divided that portion of the country traversed by the expeditionary forces into three regions, according to the principal rivers draining them—the Mareb, the Atbara, and the Abai, or Blue Nile. In the northern region, that drained by the Mareb, Mr. Markham found plateaux 8,000 feet high, mountain-masses, and ridges from 9,000 to 11,000 feet high, wide valleys surrounded by the plateaux at a height of 7,000 feet, and deep ravines and river-beds varying in height from 4,500 to 6,000 feet. The plateaux consist of sandstone overlying a schistose rock 4,000 feet thick, and this again rests on gneiss. In the region of the Atbara the most striking physical feature is the flat-topped sandstone cliffs,—the famous *ambas*. The southern region is entirely composed of volcanic rock, and is wholly mountainous. After describing these three regions in a somewhat detailed manner, Mr. Markham concluded as follows:—"It will be seen that the region which I traversed with the expeditionary field-force from the sea-coast to Magdala, a distance of more than 300 miles, is one of considerable geographical interest; and the operations of the expedition have added much to our knowledge. On the coast, the great system of eastern drainage comprised in the Ragolay and its tributaries has been discovered; and old Father Lobo's story of one of the pleasantest rivers in the world, with sweet herbs growing along its banks, flowing through a country which has always hitherto been believed to consist of a salt desert, has thus been explained. The remarkable passes from the coast to the highlands of Abyssinia have been thoroughly explored; the mountain chains forming the watershed of a vast region have been examined; and the numerous sources of the great fertilizing tributaries of the Nile have been accurately surveyed. Besides the observations which I have taken, that most zealous and indefatigable of quartermaster-generals, Colonel Phayre, has completed a rough, but at the same time a most useful, survey of the whole country that has been traversed. Dr. Cooke, in spite of severe illness, which would have disabled a less zealous inquirer, has done much valuable meteorological work; and the officers of the Indian Trigonometrical Survey have completed the mapping of the Abyssinian highlands."

Mr. Markham's paper was followed by one from Dr. H. Blanc "On the Native Races of Abyssinia." In it the author mentioned the characteristics of the Amharas, the Tigre people, the people of Lasto, the Shoas, the Falashas, the Kainawnts, the Agaws, the Zalas, the Waitos, the Figens, and the Wallo Gallas. He spoke of the last-mentioned tribe as having come from equatorial Africa, and as being, before Theodore's rise, the most powerful people in Abyssinia. They are a brave and handsome race, and now that their great enemy is no more, they bid fair, should they, burying in oblivion all internal rivalries and petty jealousies, once more unite, to overrun Abyssinia and impose on the debauched and sensual Christians of that country the false creed of the Koran. Mr. Rassam appeared before the audience at the request of the President after Dr. Blanc had done reading his paper, but he could not be prevailed upon to make a speech.

A paper "On the Topography of Sinai," by the Rev. F. W. Holland, followed by a discussion, finished the first day's proceedings.

On the second day (Friday), Mr. W. Hepworth Dixon, editor of the 'Athenæum,' read a long paper "On the Great Prairies and the Prairie Indians." This was the most attractive and interesting paper of the day, and drew together a crowded audience. It was graphic and picturesque in the extreme, and excited frequent outbursts of applause and laughter. The points to which Mr. Dixon seemed to desire to direct most attention were two. There was, first, the fact that the great prairie land is not a desert, but is, instead, a land teeming with life, both animal and vegetable; and, secondly, the illustration afforded by the condition of the tribes of prairie Indians of the philosophy of progress in civilization. Mr. Dixon's opinion is that the prairie Indian is in the first stage of civilization, that of a hunter of wild game, and that in passing into the third stage, such as that of a Norfolk farmer, he must pass through the condition of a herder of goats and kine. The three grand stages are illustrated by a prairie Indian, a Bedouin Arab, and a Norfolk farmer. A hunter is a wild man; a herdsman is a tame man; and a husbandman is a social man. The experience gained among the Kirghees of Central Asia by M. Vambery, the famous Hungarian traveller, enabled that gentleman to speak in support of Mr. Dixon's views; and the Bishop of Labuan, with twenty years' experience in Borneo, considered himself justified in supporting those views. The Bishop had found in Borneo the hunting savage, the herding savage, and the farming savage. He said the farming savage was so debased that he would only be raised to the scale of a Norfolk farmer in three or four generations.

In a paper "On the Inhabitants of Cyrenaica and Western Libya," Captain Lindesay Brine, R.N., mentioned some interesting facts which he had learned in the spring of the present year while examining the African coast between Berenice on the west, and Egypt on the east. "The Rivers and Territories of the Rio de la Plata" formed the subject of the following paper, the author of which was Mr. T. J. Hutchinson, consul at Rosario. Mr. Hutchinson's remarks referred to the physical geography of La Plata, to the prospects of the Centro-Argentine Railway Company, the seat of war in Paraguay, and to the sources of the Paraguay and the Amazon in the diamond mine territory of Matto Grosso in Brazil.

The last paper read on Friday was by Mr. A. Waddington, a North American colonist, who most enthusiastically advocated the construction of an overland railway route through British territory, from the Atlantic to the Pacific, from Ottawa to the head of Bute Inlet, opposite Vancouver's Island. He carefully described the character of the whole route in exploring and surveying which he had spent many years and sunk a large fortune. The length of the railway would be 2,885 miles, and the estimated total cost 27,000,000*l*. Captain Richards said that we should soon have a railway carried across to British Columbia if it were only possible to shift Great Britain across the Atlantic to the entrance of the river St. Lawrence. Notwithstanding the fact that people in this country could scarcely be expected to take the same amount of interest in the project as Mr. Waddington took in it, he (Captain Richards) believed that sooner or later it would be carried out. (It may be mentioned that Mr. Waddington has also had this subject before the Royal Geographical Society.)

The proceedings on Monday opened with a paper "On Explorations in Greenland," by Mr. Edward Whymper, a gentleman whose reputation as an adventurous and scientific traveller has rapidly reached the highest rank. This paper proved to be highly interesting to the *savans.* It may be remembered that Mr. Whymper was commissioned a year or two ago, by the British Association and the Royal Society, to make a series of expeditions into the interior of Greenland, for the purpose of collecting such natural history data as might be available for use in determining the former climatic conditions of the country. The first of these expeditions was made during the summer of 1867, and the paper read by Mr. Whymper gave an interesting account of the present flora as compared with that of the miocene period, of the animals which at present inhabit the country, and of the modern Greenlanders, both from a physical and a moral point of view. The former flora embraced firs, birches, poplars, oaks, beeches, chesnuts, planes, walnuts, hazels, the vine, and the magnolia, while the largest shrubs now found in the country have a maximum diameter of scarcely an inch. The rich collection of plants brought home by Mr. Whymper is now in the hands of Professor Heer, of Zurich. Glacial action has been so great in Greenland that the whole surface has been worn and polished in such a manner that it is impossible to walk in other than native boots; European boots are quite useless. It is gratifying to learn from Mr. Whymper that the morality of the Greenlander stands very high. Honesty is scarcely a virtue with him, *it is a habit.* An interesting discussion followed the reading of this paper, Sir Charles Lyell, Admiral Ommaney, Sir E. Belcher, and Professor Rolleston taking part in it. The last-named gentleman said that he had examined sixteen skulls brought home by Mr. Whymper, and his conclusions were that they had been the skulls of savage people of carnivorous habits. They were quite destitute of sutures, as is the case in the *carnivora.* Admiral Sir E. Belcher would not consent to have the Greenlanders called Esquimaux; there is no communication between them, and the same is true of the Esquimaux and the Red Indian.

On the subject of "Overland Communication between India and China," General Sir A. Scott Waugh read a report on behalf of the Committee appointed at the Dundee Meeting of the British Association; and the business of the day was concluded by an interesting paper from Dr. E. Perceval Wright "On the Seychelles Islands," unless we mention one by Sir Walter Elliott, "On Sepultural Remains in Southern India," which was not read from want of time, and its general scope only was indicated by the author.

No fewer than eight papers were set down for reading in Section E on Tuesday. Of course, it would scarcely have been possible to persuade their authors that the papers were uninteresting, even though the attempt had been made to do so; and from sheer necessity the papers had in one or two instances to be read in snatches or their details to be mentioned in abstract. Not the least valuable of the papers was the first on the list. Its subject was "The North-east Turkish Frontier and its Tribes," by Mr. W. G. Palgrave, the gentleman whose picturesque and interesting description of his Arabian experiences is so fresh in the public mind. The paper in question contained an account of a visit paid by Mr. Palgrave to the north-east part of the Turkish empire in the summer of last year. The region lies to the south of the Caucasian mountains, with Mount Ararat in its centre. It is very fertile, admirably adapted for human habitation and increase, and difficult of access, owing to the nature of the mountain passes which surround it on all sides and render it a kind of natural citadel. Mr. Palgrave's account of the people occupying this densely populated region, their physical, intellectual, moral, and social character, whence they came, the rapid increase in their numbers, &c., greatly interested the audience. Grants of land are given to all persons who come from without and settle in this part of Turkish territory, and the fullest civil and religious liberty is enjoyed by them. The population is composed of Turcoman tribes, who are discontented with the Russian government, of Kurdish tribes; the victims of anarchical rule in Persia; and of Georgians and Circassians. The commingling and intermarriage of these various races are producing the very best examples of the Georgian type of the human species. Mr. Palgrave is very hopeful of these people forming an effectual barrier to the further encroachments of Russia, and that they may in course of time form a separate and independent nationality, and, as the allies and friends of Britain, help to develop the great means of communication between Europe and India by the valley of the Tigris and the Euphrates, of which they hold the key.

Much curious information was mentioned in a paper by M. Vambery "On the Uigurs," the most ancient Turkish tribe which settled in Chinese Tartary, a people who had a literature, and were very fond of books, at a time when the western world was profoundly ignorant and barbarous. In a paper by Mr. H. H. Howorth, "On the Nomade Races of European Russia," some opinions were expressed regarding the origin of the Hungarian race, which M. Vambery regarded as being very heterodox and not based upon reliable data. That learned gentleman stated that the chief object which he had in visiting Central Asia was to discover, if possible, the true origin of the Hungarian race. He had come to the conclusion that it was neither Uigurian nor Turkish, and that the question must, in the meantime, remain undecided, from want of sufficient materials bearing upon it.

Dr. R. J. Mann, special commissioner from the colony of Natal, read a paper "On the Gold-fields of South Africa," in which he communicated much information obtained from private sources regarding those newly-discovered gold-fields. From some remarks, by Mr. Tennant, the mineralogist, it would seem that South Africa is almost as rich in diamonds as it is in gold. Two diamonds which he had seen from the Orange river district he valued at 400*l.* and 200*l.* respectively, and he had received a model of another diamond which was worth from 350*l.* to 400*l.*

The only other paper calling for special notice on account of its great interest, was "On the Victoria and Albert Rivers, North Australia," by Mr. T. Baines, the well-known artist and traveller, and it now remains for us simply to mention the titles of the other papers which, in whole or in part, were brought under the notice of the Section:—"Topography of Vesuvius, with an Account of the recent Eruption," by Mr. J. Loglan Lobley; "On the Tehuelche Indians of Patagonia," by Mr. Consul Hutchinson; and "Description of Hong Kong," by Mr. Granville Sharp.

It cannot be said that there was anything so peculiarly and superlatively interesting in the proceedings of Section E, as to make the Norwich Meeting one to be specially remembered. The origin of man, the unity or plurality of the human species, the characteristics of the negro, the origin of civilization, and other cognate subjects, on which the theological polemic and the man of science are so prone to differ, and the debates upon which are always keenly relished by the general audience and by the general public, were almost entirely absent from the discussions; still a considerable amount of good and satisfactory work was done.

MECHANICAL SCIENCE. (Section G.)

The proceedings of this Section were inaugurated by an address from the President, Mr. G. P. Bidder, in which he touched on several topics which are occupying public attention. First among these was the question of the supply of water to towns, its utilization for manufacturing and other purposes, and the requisite means to prevent its pollution by refuse and sewage, a subject which he illustrated by a reference to the rivers of the Norwich district, and their influence in forming and preserving the harbours on the sea-coast. As the engineer employed in extending and improving the harbour of Lowestoft, Mr. Bidder can speak with authority on this subject; indeed to him it is due that that town can in some branches of trade compete with Yarmouth as a landing-place and depôt. As connected with the water-question, he referred to the undertaking of the Suez Canal, and to the enormous evaporation, amounting to one inch per diem, in the district through which it runs: in the course of this work the Bitter Lake, a surface of about 150 square miles, which is now dry, will have to be filled from the waters of the Red Sea, and it will be curious to note the influence on the surrounding atmosphere of the evaporation from this source, which on the above supposition must nearly reach the astounding quantity of 360,000,000 cubic feet per diem, or 250,000 feet per minute.

Adverting to our armour-clads, the President argued that, in order to render the combined operations of a fleet effective, the vessels constituting it ought to be as nearly as possible of the same speed, and that the protection to be afforded to a ship by armour-plating should be made subservient to speed and steadiness. He deprecated the reception of the performance of a ship in smooth water as any test of her speed and behaviour when at sea. Turning to the question of our coast defences, Mr. Bidder expressed his opinion that the advance in the science of gunnery had put an end to the embrasure system; he considered that men were really better protected in the open country than when crowded together behind embrasures and exposed to the fire of a powerful artillery. His address concluded with some remarks on the improvements in telegraphy, expressing a hope that this country might before long possess an independent line of telegraphic communication with India, by way of Gibraltar and the Cape.

With two or three remarkable exceptions, the papers read in the Mechanical Section were neither so able nor so interesting as those which have been contribnted at former meetings of the British Association. The Section, though fairly, was never very numerously attended, and we missed the presence of several men eminent in the engineering world, who are generally with us at our annual congress. Norwich being the capital of a strictly agricultural county, the town selected for this year's meeting presented few attractions to mechanical engineers. To the civil branch of the profession the drainage of the low-lying lands of Norfolk is a question of some importance; and a paper was read by Mr. R. B. Grantham "On the Broads of East Norfolk, having reference to Water-Supply, Storage, and Drainage," possessing some local interest, but which without maps of the district to which it relates would be unintelligible to the general reader.

The paper which perhaps more than any other attracted attention, and gave rise to an interesting discussion, was that by Mr. Whitworth, "On the Proper Form of Projectiles for Penetration through Water." His object was to show that a flat-headed shot when fired at a small angle of depression is better calculated to penetrate an object aimed at under water than one with a hemispherical or conical head. The author exhibited to the meeting the photograph of a plate which had been placed with its bull's-eye under water and fired at with a one-pounder gun, of which the angle of depression was 7° 7′; the projectiles used being, 1, the Whitworth steel-shot with a flat head; 2, a hemispherical-headed shot; 3, a shot with a head of the form advocated by Major Palliser. While in the first case the shot which struck close to the spot aimed at, in the second case it struck considerably, and in the third very much above that point. Mr. Whitworth, however, went rather out of his way, and certainly beyond the scope of his paper, to attack the material as well as the form of the chilled-iron shot. His objections to that projectile were: 1, that when fired at a considerable angle against an armour-plate its form causes it to glance off, while owing to the brittleness of the metal of which it is composed it breaks up; 2, that the consequent weakness of the metal necessitates a greater thickness of the sides and reduces its internal capacity as a shell.

In the discussion which followed, Mr. Bramwell defended the Palliser shell, and on the point of economy alone placed it far above a steel one. A steel shot he estimated to cost five times as much as one on the principle of Major Palliser. Its efficiency as a projectile he illustrated by the observation that a fragment of a steel shell after being fired against an armour-plate would be found to be quite hot, while in the case of one of chilled-iron no appreciable heat was developed.

In supporting Mr. Whitworth's claims for the superiority of a flat-headed shot in penetrating water, Mr. Hawksley argued, that on the principle of a flat stone selected by boys in playing "duck and drake," it seemed more probable that a projectile with a conical head would be deflected upwards from the surface of the water—in fact it would tend to ricochet. The smaller the angle between the direction of the shot and the surface of the water, the greater would be this tendency. It seemed to be also admitted by more than one speaker, that although a conical-headed shot might be superior to one with a flat head when striking at right angles, it was decidedly inferior when the angle was oblique.

Mr. Mallet called the attention of the meeting to some experiments conducted by the Russian General, Mayevski, which seem to show that the ogival-headed projectile is superior to the flat-headed, both for direct and oblique penetration. When a flat-headed shot strikes obliquely, it has a tendency to slew round and fly off backwards. On the contrary, while the ogival-headed shot also has a tendency to slew round, the result is to bury the point in the face of the armour, whereupon the shot proceeds to force its way into the plate almost the same as if it had been fired at right angles. A certain amount of power is lost even in the case of the ogive, but that which remains is exercised usefully.

Considering the national importance of the manufacture of iron and steel, the great improvements which have been lately introduced into it, and the necessity of still further reducing the consumption of coal, which, on good authority, threatens at no very distant period to outstrip our resources; it was not surprising that the papers on this subject read before the mechanical section were looked forward to and listened to with the greatest possible interest. The paper, by Mr. C. W. Siemens, "On Puddling Iron," was an attempt to trace the course of the chemical action which takes place during the puddling process; and the deduction drawn was, that the present method, which has now been maintained for many years without change or improvement, involves great loss of metal, waste of fuel and human labour, and an imperfect separation of the two noxious ingredients, sulphur and phosphorus. Experiments on a large scale, and a series of analyses of the iron in different stages of the process of puddling, appear to show that the molten metal is mixed intimately, in the first place, with a molten portion of the oxide or cinder (technically called the fettling) which forms the lining to the iron tray of the puddling chamber; that the silicon is first separated from the iron, that the carbon only leaves the iron during the "boil," and that the sulphur and phosphorus separate last of all while the iron is "coming to nature." The object of Mr. Siemens was to show that much of the waste which takes place during this complicated action could be avoided by the use of a puddling hearth, heated by means of one of his regenerative furnaces, to the advantages of which he drew particular attention. These are, that the heat can be raised to an almost unlimited degree, that the flame can be made at will—oxidizing, neutral, or reducing—without interfering with the temperature, that draughts of air and cutting flames are avoided, and that the gas-fuel is free from pyrites and other impurities which are carried into the puddling-chamber from an ordinary grate. A furnace erected, on this principle, which has been in operation at the Bolton Steel and Ironworks for eighteen months, has given most excellent results; and the process is about being adopted by Messrs. Kitson, of Leeds, and others in this country.

The production of steel by means of the mutual reaction of pig-iron, and wrought or other decarbonized iron, has been often attempted, but in consequence of the insufficient means of ensuring a very high temperature, without any practical success. Lately, however, Messrs. Martin, of Paris, have succeeded by means of the Siemens' regenerative furnace in obviating this defect, and it was to their process under the name of the Siemens-Martin process, that Mr. Ferdinand Kohn drew attention in his paper "On the Recent Progress of Steel Manufacture."

To the Messrs. B. Samuelson and Co., of the Newport Works, Middlesborough-on-Tees, is due the credit of being the first in the United Kingdom to manufacture steel for commercial purposes by this method, and, as yet, these are the only works established solely for this purpose in the country. One of the great advantages of the process, and that which fits it more particularly for the Middlesborough district, is that by it a comparatively impure metal, as the Cleveland iron is known to be, can be converted into steel at a price inferior to that of the Bessemer steel, which requires tolerably pure hæmatite iron. The process, as described by Mr. Kohn, consists in adding to a bath of pig-iron, kept at a high temperature by means of the regenerative furnace, measured doses of wrought-iron, until the stage of complete decarbonization is arrived at; the operation is then completed by the addition of a certain percentage of pig-iron, or of the well-known alloys of iron and manganese. Generally, the Siemens-Martin process appears to have a wide range of applicability: it can work up the waste of other modes of steel manufacture, it can utilize old materials, especially wrought-iron and steel, and it is applicable to white pig-iron, or pig-iron poor in carbon.

Mr. J. Jones, Secretary to the North of England Iron Trade, read a paper "On some Points affecting the Economical Manufacture of Iron," in which he introduced to the notice of the meeting the Wilson Fire-Grate and the Newport Furnace, both of which, he submitted, effected a considerable saving of material and fuel in the puddling process. Without diagrams or a longer description than our space admits of, it would be difficult to convey any clear idea of the manner in which these inventions work. The principle of the Wilson-grate is the complete combustion of the fuel before it comes to the furnace chamber, and, as has been proved from results obtained by working for a considerable length of time, the quantity of fuel required per ton of puddled iron is from 20 to 25 per cent. less than in the ordinary furnace. In the Newport furnace attention has been paid to the utilization of heat, and the waste heat is again made available: in principle, it partakes somewhat of the regenerative character of Mr. Siemens' invention. By the use of this furnace it is stated that a saving of from 25 to 30 per cent. of fuel is effected. Mr. Jones also referred to the Radcliffe process of puddling, by which five or more balls are withdrawn simultaneously from the furnace, and treated together under a heavy steam-hammer with a quick action. He claims for this method the advantage of producing homogeneous iron, not liable to lamination, in a time considerably less than that required under the process ordinarily adopted.

A paper of the greatest possible public importance was read by Mr. L. E. Fletcher "On Coroners' Inquests and Boiler Explosions." Starting from the fact that since the commencement of 1855 up to the 31st July last, 464 boiler explosions, by which 789 persons were killed and 924 injured, had occurred in different parts of the kingdom, he showed how necessary it was for the preservation of life that in every case the strictest possible investigation should take place as to the cause of the catastrophe. He urged more particularly the granting of power to the coroner to call in professional engineers to investigate and report on the condition of the boiler. Frequently the most frivolous and absurd reasons for the explosion are given and accepted by the jury, resulting in most cases in a verdict of "Accidental death," while the boiler, which in many instances, owing to defective construction, or wear and tear, is really the root of the evil, is left unexamined. In such cases, it would be possible, if the course pointed out were adopted, for the relatives of the dead or injured persons to recover pecuniary damages from the party really in fault; whether the manufacturer who has put bad material into the boiler, or the owner who has neglected to have it periodically inspected and reported sound. Especial reference was made to the Association for the Prevention of Steam-boiler Explosions, by means of which every owner could assure himself, at a moderate cost, that his boiler is in a condition fit for working without endangering the lives of all in its neighbourhood. In the discussion which followed this paper, Mr. Fletcher's arguments were illustrated by reference to a boiler explosion which occurred in the city of Norwich about two years ago. The cause of this disaster was simply that the boiler was a bad one, though new, and made under a special contract as to the quality of the plates; and this was recognized by the jury in their verdict, resulting in the recovery of heavy damages from the maker to the amount of 2,000*l*.

Professor Rankine contributed a paper "On the Probable Connection between the Resistance of Ships and their Mean Depth of Immersion;" and Mr. Merrifield one "On the Necessity for further Experimental Knowledge respecting the Propulsion of Ships." Both of these papers referred to unknown elements in the resistance which vessels meet with in their passage through the water, though those elements may be due to different causes; and urged the adoption of experimental researches for the purpose of determining them.

Interesting papers were also read by Captain Douglas Galton "On a New Ventilating Fireplace;" by Mr. P. Le Neve Foster, jun., "On the Irrigation of Upper Lombardy by Canals, to be derived from the Lakes Lugano and Maggiore;" and by Mr. J. H. Gwynne, "On an Improved Centrifugal Pump."

INTERNATIONAL CONGRESS OF PRE-HISTORIC ARCHÆOLOGY.

THE third meeting of this Congress was held at Norwich, simultaneously with the Meetings of the British Association for the Advancement of Science. It was commenced on August 20th, by the President (Sir John Lubbock, Bart.) reading the opening address, which was chiefly remarkable for containing a brief reply to the articles in 'Good Words' by the Duke of Argyll, wherein His Grace endeavours to show that there is no proof whatever that such ages as the Palæolithic, Neolithic, Bronze, and Iron, ever existed in the world, chiefly, it would seem, because archæologists cannot show that they were universal, as the same age which was an age of stone in one part of the world was an age of metal in another. This fact is perfectly true, and has always been admitted by Pre-historic Archæologists. Sir John asks, Would the Duke of Argyll object to the use of the term "Christian Era," because we have Heathens existing now as well as Christians? This is an unfortunate reply, and its fallacy will certainly be exposed by so rigorous a logician as the Duke of Argyll. We denominate this the "Christian Era," because it succeeded the birth of Christ, not because it is characterized by the prevalence of Christianity. The remainder of the address was a good popular exposition of the leading facts and principles of Pre-historic Archæology.

On the 21st (Friday), after a paper by E. B. Tylor, Esq., "On Pre-historic Races and Modern Savages," a great part of the day was occupied with reading and discussing two papers "On Stone Circles," &c.: the first, on those of Scotland, being by J. Stuart, Esq.; and the second, on the Sarsden Stones, &c., of Berkshire, by A. L. Lewis, Esq. The former author inferred that stone circles were monuments of the dead, and the latter, that they were temples. The question of temples *versus* tombs produced an animated debate. Post-historic Archæologists may some day quarrel over this question applied to our churches. They will find sepulchral remains in most of them, but not in all, and other evidence of the same nature as that we possess about Stonehenge, Carnac, &c. The probability to our mind is that such places were *always* temples and *sometimes* tombs. The other papers read this day were, "On Rock Sculptures," by H. M. Westropp, Esq.; and "On the Antiquities of the Pacific Islands" (which are not at all ancient), by J. W. Lamprey, Esq.

On Saturday, Mr. Busk exhibited an interesting collection of stone implements from South Africa, some of which had received a beautiful polish from the shifting sand in which they had been buried. Pritchard was of opinion that there had been no stone age in Africa, and until recently the abundance of iron tools and the absence of stone implements was a very remarkable fact. The question—Was there a bronze age in Africa?—still remains open. Mr. Boyd Dawkins exhibited some mammalian remains from bone-caves in Portugal;* and two other papers of very little importance terminated the day's proceedings.

The greater portion of Monday was occupied by Professor Huxley's lecture "On the Races of Mankind," and the discussion thereon. He stated that it matters very little whether we call the great groups of mankind "races" or "species." He recognized: (1) the Australoid race, having long heads, smooth soft wavy hair, and dark complexion and eyes; (2) the Negroid race, having long heads, very dark skins, and crisp woolly hair; (3) the Mongoloid type, having black eyes, black hair (usually straight and lanky), and skin of an olive to a yellowish tint, the skull varying considerably; (4) the Blonde or Xanthochroid type, characterized by fair delicate skins, yellow hair, and blue eyes, usually of tall stature, the skull varying very much.

With the Australians, Professor Huxley includes the hill-tribes of the Deccan, and the natives of Abyssinia and the valley of Egypt. The Mongoloid type is found in Central Asia, westward as far as Lapland, along the whole of the Polar regions, and through the two Americas. The Negroid type extends through the southern portion of Africa, Madagascar, the Malacca Peninsula, and includes the Abetes of the Philippines; beyond the Natural History boundary, which he termed Wallace's line, the negro becomes abundant in New Guinea, and exists in New Caledonia and Tasmania. In connection with this paper, we would refer our readers to the abstract of Dr. Haekel's pamphlet, given in the Chronicle of Archæology and Ethnology.

On Tuesday several papers were read, but we can only notice two of the most important. The first was Mr. George Rolleston's communication "On Modes of Early Sepulture in England," of which he described two of Romano-British origin, and three of Anglo-Saxon. They were, of the former: (1) in oak coffins, with nails and hoops; and (2) in leaden coffins, made like a tray, with turned-up edges, on which the lid was placed. The Anglo-Saxon methods were: (1) cremation, and the burial of the ashes in urns; this mode was practised from the time of Hengist to that of Augustine; (2) burial in shallow graves, not more than 18 inches deep; with the women were buried fibulæ in pairs, ornaments, pins, knives, and beads; and with the men were buried spears, buckles, knives, &c.; (3) burial in deep graves, in imitation of the Romano-British style.

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* See Chronicle of 'Archæology' in our July number.

The other important paper was by John Evans, Esq., "On Stone Implements in Pre-historic Times," in which the author described the result of his attempts to discover, by imitation-experiments, the mode of manufacture of flint and stone implements without the use of metal tools. He recognized four epochs in this manufacture, namely: (1) the Palæolithic period, in which the implements were fashioned by chipping only, and were always of flint; (2) the Reindeer period, of Central France, in which greater skill in flaking flint was possessed, and other hard stones were worked, though not for cutting purposes; (3) the Neolithic period, in which other materials than flint were used, and when grinding on the edge and surface was generally practised, though the hatchets were not perforated; (4) the Bronze period, in which such stone implements as remained in use were highly finished, many of the axes being perforated.

On Wednesday, the last sitting of the Congress, A. W. Franks, Esq., read a paper "On Ancient Stone Implements in Japan." They consist of barbed arrow-heads, either with or without tangs, spindle-formed spear-heads, knives or scrapers, and axes or celts, all of forms similar to the implements of Europe and America. The axes are either of basalt or jade, and the arrow-heads of flint, chert, jasper, or obsidian. The author described the popular legends relating to these objects, and remarked that the general belief in their supernatural origin shows them to be Pre-historic, and older than the existing civilization.

A paper by W. Boyd Dawkins, Esq., "On Mammalia associated with Pre-historic Man;" and one by H. Woodward, Esq., "On the Tusks of the Mammoth, from Ilford," were more Palæontological than Archæological.

The Ogham Monuments formed the subject of a paper by R. R. Brash, Esq., in which the author stated his belief that some of them were of a memorial character, and that others were boundary stones; he regarded them as Pre-Christian in date, and the people who raised them as having come from Spain.

On Thursday the members of the Congress made an excursion to Cambridge; and on Friday a Council Meeting was held at Somerset House, London.

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

There is but little to record in an agricultural Chronicle of the quarter beyond the effect of the universal drought of the past summer upon our field crops. The maxim that "Drought never breeds dearth" appears likely to prove true of 1868 so far as food for man is concerned; but every kind of succulent growth on which we depend for our winter's supply of food for the live stock of the farm has been checked so severely that food for beast will be scarce and costly. The hay crop and the root crop are both much below an average. The wheat crop is unusually productive, excepting only on light and shallow soils; but all spring-sown grain crops are deficient. There has probably never been a summer less helpful to the grass lands of the country which were, over all the Southern and Midland Counties during July and August, bleached and dried up so completely that a sheep was to be noticed on its pasture rather by its shadow than anything else; the ground it stood on being the exact colour of its wool.

Under these circumstances green crops have been possible only by the aid of artificial watering; and land irrigated, whether by spring and river water, or by sewage, has yielded extraordinary crops. On the Metropolis Sewage Company's farm near Barking, a poor thin soil on gravel, which had been in wheat last year, has produced 6 quarters of white wheat per acre with the aid of sewage only; land naturally fertile, but which had had 60 tons of grass taken from it last year under sewage dressings, is now covered with a very heavy crop of mangold wurzel, having received four dressings of sewage during the past summer. And on other fields the power of the waste drainage water of the metropolis, unaided by any other fertilizer, to produce rapid growth of grass, roots, cabbages, and potatoes, has been amply proved. Great crops also of strawberries have been grown on the sewage farm: 160*l.* worth were sold off 1¼ acre, having received no other dressing.

An unusually early harvest, got in four or five weeks before the usual time, has enabled the early autumn cultivation of a large extent of stubble land in most parts of the country; and the advantages of deep steam-cultivation will no doubt appear next year. The opportunity for a much greater extent than is commonly sown of so-called "catch crops," between the main crops of successive years, has been generally taken, and we shall have for the advantage of our sheep and cattle during winter, rape, common turnips, mustard, and winter-cabbages, to take the place of a lost Swedish turnip crop; and for early spring use, to eke out a deficient mangold crop, there is an extraordinary quantity of rye and winter vetches, Italian rye-grass, and Trifolium incarnatum, sown.

The Prize Essay of Mr. Gibbs "On Harvesting Corn in Wet Weather," has been published under the auspices of the Society of Arts,* by whom the prize was offered; and, though singularly unserviceable during the present summer, it will, no doubt, be of use in ordinary seasons. In wet summers it may indeed be the means of introducing artificial drying for many other purposes besides corn harvesting. Half-dried grass in difficult weather, and sugar-beet and chicory in the short days of October and November, may be dried by Mr. Gibbs's artificial hot-air blast at a cost which will not exceed the limits imposed upon the harvest process by the ultimate value of the crop.

Among the agricultural events of the season have been the successful Annual Meetings of the Royal Agricultural Societies of England, Scotland, and Ireland, at which cattle have once more been allowed a place, the restrictions on the home trade imposed against the spread of the cattle plague having been at length wholly removed. The attempt of the Government to pass a Bill for the establishment of separate Water-side Markets for Foreign Cattle, which should diminish the risk of a re-introduction of the plague, was defeated by the jealousy of any restriction upon the trade in food entertained by a resolute minority of the House of Commons. Whether their refusal of this kind of protection of the home interests may not, by permitting the re-introduction of foreign diseases, diminish the supply of animal food, and so increase the cost of it at least as much as the opponents of the measure feared, remains to be seen. While we write, cargoes of foreign sheep are arriving suffering from the small-pox; and we hear of rinderpest within easy reach of us upon the continent. Let us hope that the new Parliament will reconsider the decision of the last, and that every care may be taken so to regulate the importation of live-stock to our shores, that the risk of introducing the deadly plagues of the last few years may be reduced to a minimum.

2. ARCHÆOLOGY AND ETHNOLOGY.

The proposal to publish a translation of Dr. Haekel's great work, made at the Annual Meeting of the Ray Society, was not favourably received, as many portions of it were considered likely to prove distasteful to English readers. Be this as it may, whether the fact be true and the argument legitimate, or not, it is now our duty to record the publication by that author of two Essays collectively entitled 'Ueber die Entstehung und den Stammbaum des Menschengeschlechts.'*

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* Bell and Daldy.

In the first Essay, "On the Origin of Mankind," the author gives his reasons for inferring that Man has come into being by a process of development from the lower animals; and he regards the importance of the "Lamarck-Darwin" hypothesis as precisely equivalent to that of the "Copernicus-Newton" system of Astronomy, for while the latter proved the error of the old geocentric system, so the former shows the falsity of the "Anthropocentric" belief that looks upon man as the centre of an animate world created only to supply his wants.

The second Essay, "On the Pedigree of Mankind," contains the author's opinion of the line in which man's development from the lower animals took place, commencing with *Amphioxus*, and proceeding through the Lampreys and the extinct allies of the Sharks to the Lepidosirens, thence through *Proteus* and its congeners to the Tritons and Salamanders, and thus to the Monotremata (*Ornithorhynchus*). The line then passes through the Marsupials, the Lemurs, the Old World Monkeys (*Semnopithecus*, &c.), and the Anthropoid Apes (Orang, Gorilla, &c.). All the existing varieties of man the author regards as having come from one stock, but that original race he considers to be now extinct. He also believes that the various races have the same value as Natural History species, and as species he describes them. They are the following:—

I. *Homines ulotrichi:* Men with woolly hair and long heads.

1. *Homo primigenius*. Ape-like men, now extinct.
2. *H. papua*. Papuan species.
3. *H. hottentottus*. South African species.
4. *H. afer*. Central African species.

II. *Homines lissotrichi:* Men with smooth hair; heads long, short, and of medium proportions.

5. *Homo alfurus*. New Holland species.
6. *H. polynesius*. Malayan species.
7. *H. arcticus*. Polar species.
8. *H. mongolicus*. Yellow species.
9. *H. americanus*. Red species.
10. *H. caucasicus*. White species.

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* 'Sammlung gemeinverständlicher wissenschaftlicher Vorträge,' herausgegeben von Rud. Virchow und Fr. v. Holtzendorff. Serie III. Hefte 52 & 53. 1868.

He does not deny that it is sometimes difficult to draw the line between these groups, but observes that the same difficulty exists in treating of species belonging to other groups of the animate world.

The 'Anthropological Review and Journal of the Anthropological Society' for July contains nothing that we need notice at any length. There are but two descriptive papers in the number, both being in the 'Journal' portion, and both printed in abstract. One is "On Vocal and other Influences upon Mankind from Pendency of the Epiglottis," by Sir Duncan Gibb, Bart., and the other by Lieut. Oliver "On the Hovas of Madagascar," who are described as having a Mongol physiognomy, with affinities to the Malays.

The 'Norfolk News' tells its readers that Anthropologists "consider subjects of much the same kind as those which come under the notice of the Ethnological Society, except that they confine themselves to the study of man, whilst the Ethnologists deal also with the migrations of plants, and things not directly connected with man!"

In M. Fouqué's 'Premier Rapport sur une mission scientifique à l'île de Santorin,' is a description of the remains of buildings which have been found buried beneath the "Tuf ponceux" forming the uppermost volcanic deposit on the south-east coast of Therasia, and which he regards as of Pre-historic date. The walls consist of irregular unworked blocks of lava, irregularly placed, the interspaces being filled up with an earthy material mixed with vegetable matter, but devoid of any calcareous admixture. In the interior of the chambers (which were numerous, and some of which were furnished with windows) the explorers found a quantity of obsidian knives, vases of turned pottery and lava, a human skeleton, bones of ruminants, &c. Under similar Tuff on the Island of Santorin M. Fouqué found a bed of volcanic cinder containing obsidian knives and two gold rings; and at a neighbouring locality a similar cinder-bed contained two tombs, which yielded to his search nothing but a *Byzantine coin*, regarded by the author as having been placed therein at some period subsequent to the formation of the tombs. In other tombs, but above the Tuff, he found pottery (turned) exactly like that from the buildings at Therasia.

M. Fouqué believes that we have in the structures last mentioned the remains of dwellings (as shown by the existence of windows), which were built on the scoriaceous lava which underlies the Tuff *prior* to the eruption of the latter. As no implements of the ordinary metals have been discovered, he refers the whole of the remains found at Therasia to the Stone age. He suggests that the obsidian knives, the pottery (some of which is remarkable for the elegance of its form and the beauty of its decoration), and the gold rings were all imported, because the materials are not to be found either on Therasia or Santorin. The antiquity of this "Stone age" M. Fouqué illustrates by showing that *since* the eruption of the Tuff the foundering of the bay took place, because the Tuff and the subjacent lavas are similarly scarped. In certain localities the Tuff is overlain by a bed of rolled pebbles containing marine shells, showing that these points have been submerged since its eruption. Now, previous to all these events M. Fouqué believes that the stone walls of Therasia were built, and that the inhabitants imported their obsidian implements, pottery, &c.; and he explains the discovery of similar objects in tombs belonging to a date subsequent to these occurrences by suggesting that the trade, which was interrupted by the eruptions and the foundering of the bay, was subsequently renewed when the islands were re-peopled. The foundering of the bay is the most recent event with which we have to deal; and M. Fouqué considers that it must have occurred not later than the fifteenth century before Christ.

This is a wonderful history, and, if confirmed, it will overturn our previous ideas of the "Stone age;" but although M. Fouqué states that the Tuff is not *remanié*, he does not advance one single fact in support of his statement; and when we consider the difficulty of proving it in such a region, and the discovery of similar pottery and obsidian implements in tombs more recent than the Tuff, we feel inclined to believe that the Stone Houses of Therasia have been buried by a land-slip, and are equally more recent than the date which M. Fouqué assigns to them.

The 'Rapport sur les découvertes géologiques et archéologiques faites à Spiennes en 1867,' by Messrs. A. Briart, F. Cornet, and A. Houzeau de Lehaie, has precisely the opposite tendency to M. Fouqué's report just noticed, as it seems to show that the Stone age continued to a period subsequent to the last modifications of the surface in Belgium. It appears that near Spiennes there occur two horizons which have yielded flint implements. The older of these is a Quaternary gravel resting upon Eocene sands, and yielding remains of the Mammoth, *Rhinoceros tichorhinus*, *Ursus spelæus*, *Felis spelæa*, and other extinct animals; about its age there is no question whatever. Above this is a freshwater deposit locally termed Ergeron, the lower portion of which has yielded bones of the Mammoth and of *Rhinoceros tichorhinus*, with a fragment of a shell of *Unio pictorum;* and in its upper portion shells of terrestrial and freshwater mollusca belonging to existing species. Above this bed, and covering it and all the other formations of the district like a vast mantle, is the Brick-earth, on the *surface* of which, at Spiennes, have been found flint implements, pottery, bone tools, &c., which the late M. Tolliez originally referred to the position now assigned to them by the authors of this report. M. Tolliez's opinion had been contravened by M. Malaise, who regarded the worked flints, &c., as of older date than the Brick-earth, and as therefore belonging to the Quaternary period. The construction of a railway having exposed some sections and rendered probable a solution of the problem, a commission was charged with the duty of attempting it, and the result is that the authors of this report confirm M. Tolliez's original conclusion, and refer these newer implements to the Polished Stone period; but, with one exception, the implements are not polished.

M. S. Chavannes has edited a pamphlet, by the late M. Morlot, entitled 'L'Archéologie du Mecklenbourg, d'après les travaux du Dr. Lisch, comparée à celle de l'Europe centrale. Première Partie. Age de la Pierre.' It appears that this was to have formed one chapter in a general work which the lamented author was preparing previous to his last illness, and it is the only one left in a sufficiently forward state for publication. It contains descriptions of the tombs known as "Hünenbett," or "Reisenbett" (Giants' bed) and the Hünengrab, or Giants' tombs; they consist of a mass of earth containing a kind of chamber formed of large unworked blocks of stone, the earth being raised nearly to the upper surface of the horizontal roof-blocks, and the mound is ornamented by a circle of upright stones placed at its circumference. These structures are popularly believed to contain immense treasures. Other tombs, each consisting of three upright blocks at right angles (forming three sides of a rectangle) covered by a horizontal roof-block, which are usually termed Dolmens, are known to the people of the country as "Steinkisten" and "Steinhäuser." Cromlechs also occur in Mecklenbourg, and are known to the inhabitants by the name of "Steintanz." The implements consist of flint-knives, flakes, arrow-heads, &c., and a few implements of quartzite and diorite. The author also mentions pieces of amber pierced and much ornamented, and some tools of deer's horn.

3. ASTRONOMY.

(*Including Proceedings of the Royal Astronomical Society.*)

As we write, intelligence has been received from three of the expeditions sent out to view the eclipse of August 18th.

Major Tennant reports that the sky was covered with light fleecy clouds, but the eclipse was in the main successfully observed. As Major Tennant's party had had assigned to them the task of photographing the eclipse, we may assume from his account that several photographs have been taken. This is important. We shall not be able to judge of the value of the photographs until the enlarged pictures have been examined, but from the quality of the instrument, constructed for the party by Mr. Browning, we may safely assume that the views will prove valuable and instructive.

Dr. Janssen, who was at the head of the French expedition, has telegraphed to Paris that the spectrum of the red prominences has been observed. The result he describes as "remarkable and unexpected." He does not state what is the exact nature of the spectrum; but as he adds that the protuberances are gaseous, we are enabled to conclude that it consists of bright lines. The protuberances had never before been submitted to spectroscopic analysis, and considerable doubts had existed among astronomers respecting their real nature. For the most part, however, astronomers had supposed the protuberances to consist of matter resembling our terrestrial clouds; that is, formed by the condensation of invisible vapours into minute liquid globules. This opinion will now have to be abandoned. These enormous masses, many of which exceed the planet Jupiter in volume, must now be recognzied as consisting principally of luminous gas. They are, in fact, flames—in reality as in appearance. This result is one of the most interesting which has for a long time been obtained by astronomers.

Lieut. Herschel sends a telegram confirmatory of Dr. Janssen's. He appears to have had unfavourable weather, but one protuberance was caught in the spectroscope, and the spectrum found to consist of bright lines. He adds, that no bright lines were seen in the spectrum of the corona. He found the polarization of the corona to be solar.

We shall await with interest the publication of fuller reports of these observations.

Mr. Huggins has made a very important series of observations upon the second comet of the year. This object was discovered by Winnecke, at Carlsruhe, on June 18, and also independently on the same night by M. Béquet, Assistant-Astronomer at the Observatory of Marseilles. Mr. Huggins found the comet to consist of a nearly circular coma, which became rather suddenly brighter towards the centre, where there was a nearly round spot of light, from which a tail could be traced for nearly a degree. The spectroscope resolved the light of the comet into three very broad bands, which do not correspond either in appearance or in position with the bands seen in the spectrum of Brorsen's comet. The brightest is in the middle. Its least refrangible end is the brightest, and is somewhat less refrangible than the double line *b*. The more refrangible end of the band lies about one-third of the way from F towards *b*. For about two-thirds of its length from the brightest end this band is almost uniformly bright; but from thence towards its more refrangible end it diminishes considerably in brightness and in apparent breadth. The more refrangible of the other two bands is considerably more refrangible than F. Like the former, its least refrangible end is the brightest, and it diminishes almost uniformly both in brightness and in breadth from that end uniformly to the other. The least refrangible band lies between D and E, and is faintest towards its extremities. The bands could not be resolved into lines. All of them were brightest in the middle of their breadth—an appearance due, of course, to the superior brilliancy of the comet's nucleus. But the apparent diminution of the breadth of the two more refrangible bands must not be ascribed to any difference in the spectra of the coma and nucleus, since it is clearly due to the diminution of the comet's light from the centre towards the circumference. The effect of this diminution would be to render the edges of the fainter parts of the spectrum invisible. The marginal portions of the coma were found to give the same spectrum; but when the light became very feeble Mr. Huggins imagined that he could trace a continuous spectrum underlying, so to speak, the discontinuous one. The tail was too faint to exhibit any spectrum.

But the most remarkable part of Mr. Huggins' researches remains to be mentioned. He found that the spectrum of the comet presented so close a resemblance to diagrams he had formed in 1864 of the spectrum of carbon, that he was induced to make a more exact comparison. Dr. Miller was present while the requisite observations were being made, and took part in them. Our space will not permit us to enter as we could wish into a full account of the arrangements made use of by Mr. Huggins. It must suffice for us to state that the spectrum of carbon, as seen (in combination with the hydrogen spectrum) when the spark from an induction coil is taken through olefiant gas, was brought into direct comparison with the spectrum of the comet. Mr. Huggins and Dr. Miller were both satisfied that within the limits of the instrument's power of indication the two spectra were coincident, not only in the position of their bands, but also in their general character and their relative brightness. The observations subsequently made by Mr. Huggins confirmed this impression. The lines due to hydrogen were not seen in the spectrum of the comet.

Mr. Huggins speculates with his usual acumen and caution on the remarkable discovery above recorded. The great difficulty is to understand how a substance so fixed as carbon should be volatized when at considerable distance from the sun. In the case of a comet which approaches the sun very nearly, one can understand that effects should be produced differing wholly in character from anything we are familiar with on earth; but at the time of observation Winnecke's comet was not near to the sun. However, as Mr. Huggins remarks, we can only regard the difficulty as one of degree. We are presented, in the case of the gaseous nebulæ, with instances of gas maintained permanently in a luminous state,—a phenomenon wholly inexplicable by any of the relations which terrestrial physics bring under our notice. Therefore we are forced to acknowledge that beyond the limits of our atmosphere, relations may subsist with which we are as yet, and perhaps may for ever remain, unfamilar.

M. Otto Struve has twice been able to observe the spectrum of the Aurora Borealis. He finds that it consists of one line, so that the light is monochromatic. The line falls near the margin of the yellow and green, about the position 1259 on Kirchhoff's map.

In the 'Comptes Rendus' for 3rd August there is an account of a fall of meteorites which took place on February 29th, 1868, in Piedmont, at about half-past ten in the morning. A violent detonation was heard in the *arrondissement* of Casale, and was immediately followed by another explosion and several minor discharges. While the noise continued a strange irregular mass of matter, enveloped in smoke, was observed at a considerable height above the ground. Other observers saw several masses moving from N.W. to S.E. Some labourers noticed the fall of a shower of fragments. Some of them which fell near Mount Conti were examined, and found to contain silica, sulphur, phosphorus, copper, metallic iron, oxide of iron, nickel, manganese, chromate of iron, aluminium, magnesia, and potash. Others which fell at Villeneuve contained also lime and soda.

The number of the asteroids has now been raised to one hundred, the ninety-ninth asteroid having been discovered at the Marseilles Observatory, and the hundredth by Professor Watson, of Detroit, Michigan.

The planet Jupiter is now favourably situated for observation. His belts are at present very distinctly marked. We have had some magnificent views of the planet with one of Mr. Browning's 12-inch silvered-glass reflectors; and should wish to call the special attention of observers to the corrugations of the principal northern belt (they have remained visible for a long time, and will doubtless continue to be seen for some months), and to the strangely-shaped clouds which streak the principal southern belt.

There will be a transit of Mercury on the morning of November 5th. The transit begins an hour-and-three-quarters before sunrise (which takes place at three minutes past seven), and ends two hours after sunrise. The planet will pass from east to west across the sun's disc, the point of ingress being 165° towards the east from the North Pole; and the point of egress 113° towards the west.

There is little probability that the shooting-stars of November 14th will be seen in any part of Europe this year. The calculated period of maximum display is about half-past one in the afternoon of November 14th. The display will probably be seen in New Zealand, and possibly a few Europeans who may find themselves at that time in parts of the Pacific nearly on the meridian of New Zealand may send us accounts of phenomena observed on the occasion; but there is reason to fear that the display will nowhere be properly watched by experienced observers.

PROCEEDINGS OF THE ROYAL ASTRONOMICAL SOCIETY.

We mentioned in our last Chronicle the statements made by Mr. Abbott respecting the nebula round η Argûs. We must now consider them somewhat more in detail, and examine at the same time Sir John Herschel's views respecting the supposed changes in the figure and aspect of the nebula.

In the first place a remarkable change would seem to have taken place in the luminosity of the nebula itself. On a clear fine night the object is twice as bright as the Nubecula Major, and three times as bright as the Nubecula Minor. In twilight it is seen as soon as a star of the second or third magnitude, the light being white and more diffuse; very like a small woolly cloud on a blue sky, seen in sunlight. Now Sir J. Herschel states that in 1832 no nebulosity could be perceived with the naked eye, even on a dark night, and "assuredly not in twilight such as just to allow stars of 2–3 magnitude to become visible." Both the nubeculæ are completely obliterated in twilight of this sort.

Then the arrangement of the nebulous masses would seem, if Mr. Abbott's diagrams can be trusted, to have undergone the most remarkable variations, not merely since the date of Sir J. Herschel's observations, but even during the last few years. The instrument made use of by Mr. Abbott was a 5-feet equatorial, by Dallmeyer. The light-gathering power of such an instrument is of course not comparable with that of Sir J. Herschel's 18-inch reflector; but it seems impossible to imagine that a mere difference in the amount of light should cause an object resembling that figured by Sir J. Herschel to assume the appearance presented in either of Mr. Abbott's drawings. These drawings also bear not the least resemblance to each other; and Mr. Abbott states that the position and figure of the nebula presented in the two drawings he has sent to the Society, are far from being the only ones in which the object has appeared. "A system of photographs would be the only means," he says, "of assisting materially the recognition of the principles of irregularity which pervade the whole structure of the nebula."

On this point Sir J. Herschel remarks that "there is no phenomenon in nebulous or sidereal astronomy, that has yet turned up, presenting anything like the interest of this, or calculated to raise so many and such momentous points for inquiry and speculation. The question here is not one of minute variations in subordinate features, which may or may not be attributable to differences of optical power in the instruments used by different observers, as in the case of the nebula in Orion, but of a total change of form and character—a complete subversion of all the greatest and most striking features—accompanied with an amount of relative movement between the star and the nebula, and of the brighter portions of the latter *inter se*, which reminds us more of the capricious changes of form and place in a cloud drifted by the wind, than of anything heretofore witnessed in the sidereal heavens."

Not less remarkable is the change which, according to Mr. Abbott's diagrams, would seem to have taken place in the arrangement of the fixed stars which are strewn over the nebula. Sir John Herschel determined during 1834–7 the position of no less than 1,200 of these; and during all the course of his observations never found reason to suspect the situations of any of these to be variable *inter se* or with respect to the star η. Mr. Abbott's drawing shows 150 stars of various magnitudes, and Sir J. Herschel has been unable to identify any one individual with any one in his catalogue. "What then," he says, "are we to conclude? Not only the nebulous masses would appear to have drifted away from their situations in 1835, but the stars of the whole region over an area of nearly two-thirds of a square degree, including stars of the 6th, 7th, and 8th magnitudes, to have either assumed new configurations *inter se*, or to have bodily fled away and given place to a new set."

Sir J. Herschel concludes his paper on Mr. Abbott's statements by expressing the hope that some southern observer furnished with an equatorially mounted telescope would without further delay set to work in earnest, and map down the stars visible in this most interesting area, down at least to the 10th or 11th magnitude. The questions raised by Mr. Abbott's paper "are of the last importance," says Herschel, "and *must* be settled."

Father Secchi, in a letter addressed to Admiral Manners, describes the spectra of fifty red stars. He examined these with a spectroscope, the construction of which had been improved (in the Padre's opinion) by the use of cylindrical lenses (only) for the eye-piece, which was made by M. Merz, and worked admirably. He points out that a new type of stars appears in the list, *viz.* that of stars having a spectrum of three large coloured zones. He has already found several of that type. He is particularly surprised "to see some zones always at the same places, so that there is a great cosmical law which is about to come forth; but for the present," he adds, "we must wait until the review of all the stars has been accomplished." It is to be wished that the good Padre would make use of apparatus comparable in power and accuracy with that which Mr. Huggins has applied to spectroscopic analysis. We should then be better able to form an opinion of the value of his researches. At present it is impossible to avoid entertaining a suspicion that the apparatus employed by him is not powerful enough for researches of such extreme delicacy as those in which he is engaged.

Mr. Brothers, to whom we owe the valuable catalogue of double stars, published by the Manchester Literary and Philosophical Society, supplies a paper on the name of the star ξ Scorpii. In Flamsteed's catalogue this star is called 51 Libræ. This was undoubtedly a blunder on Flamsteed's part, as the star belongs to the set of stars which form the northern claw of the Scorpion. But we doubt very much whether it would now be wise to attempt to alter Flamsteed's nomenclature. Mr. Brothers thinks it would, and he quotes Mr. Dawes's opinion in favour of the change. "Libra already has three ξ's," says Dawes, "and without this star Scorpio has no ξ at all." But there is, in truth, no particular force in this reasoning. Pegasus has no δ (Bayer's δ Pegasi being also called α Andromedæ) and Auriga has no γ (Bayer's γ Aurigæ being also called β Tauri); yet no inconvenience results from either defect. On the other hand Flamsteed's nomenclature has been so generally adopted in scientific treatises on the stars, that inconvenience would follow if a star to which he had assigned a number under one constellation, were to be included in another. The nomenclature suggested by Mr. Brothers, "ξ Scorpii (= Fl. 51 Libræ)" is far too clumsy for general use.

Mr. Brothers complains with some justice of the use made by Mr. Chambers of the catalogue mentioned in the preceding paragraph.

Major Drayson supplies an interesting paper on the longitudes assigned to fixed stars by Ptolemy. He is disposed to attribute the uniform error of about 1°, noticed in Ptolemy's longitudes, to that astronomer's ignorance of the laws of refraction. Assuming that Ptolemy fixed the positions of stars by a reference to the moon, and that he determined the position of the moon with reference to the sun by observations made when the moon was near the zenith and the sun on the horizon, we obtain an error of about 1° (one-half due to the apparent diminution of the moon's distance from the sun, and the other due to the apparent diminution of the stars' distance from the moon). We believe, however, that the opinion of Delambre, that Ptolemy formed his catalogue from that of Hipparchus by applying a correction for precession, and that the correction was 1° in 100 years, instead of the true value $50' \cdot 1$, is far more probable than Captain Drayson's. The uniformity of the error suggests that some such explanation as Delambre's is the true one.

If Ptolemy had made all his observations in the manner suggested by Captain Drayson, an uniform error would have appeared in the resulting longitudes. But that method must be looked on as exceptional, being (as Captain Drayson admits) "an extreme case, and one giving the greatest amount of error." In ordinary cases refraction would not produce nearly so large an error as 1° in longitude.

Mr. Cooke describes a new driving-clock for equatorials. In this arrangement the pendulum is a half-second's one, with a heavy bob, adjusted by sliding the suspension through a fixed slit. The scape-wheel is a double one, each wheel having four teeth: the teeth of one wheel strike on one pallet, those of the other wheel on the other pallet. The wheels are arranged in the form of the letter U. At the end of one branch is the scape-wheel, at the end of the other is an air-fan. The large driving-wheel and barrel are situated at the bottom or bend of the U. The scape-wheel and the two next wheels have an intermittent motion; all the others have a continuous motion. We have not space to describe how the change from one motion to the other is effected. It appears, however, that the arrangement is perfectly satisfactory. Mr. Cooke considers that a clock constructed on the same principle, connected with and giving motion to a cylinder, would make an excellent chronograph.

Mr. Browning describes two drawings of Jupiter, one made on September 12, 1867, with a $10\frac{1}{4}$-inch reflector, and the other on December 22, 1867, with his own $12\frac{1}{4}$-inch reflector; in each case the power was 200. On both drawings a dark belt, to the north of the bright equatorial cloud-belt, is seen to have a rather uniformly corrugated appearance on the lower or northern edge. As a similar marking appears in Mr. De la Rue's well-known drawing of Jupiter, taken in October, 1856, Mr. Browning is inclined to think that the mark may possibly indicate the conformation of the actual surface of the planet, or at least some peculiar condition of the planet's atmosphere over a particular portion of Jupiter's globe.

Major Tennant supplies some interesting particulars respecting the Zodiacal Light as seen at Calcutta. He has always found the shape to be a portion of a long ellipse or parabola, ill-defined at the outlines, and fading away, with a marked condensation of light towards the axis and horizon.

Linné still continues to attract the notice of observers. We have papers from Messrs. Webb, Prince, and Birt, on the appearance of this crater. The opinion seems to be gaining ground, however, that no change has really taken place on this part of the moon's surface.

Mr. Stone supplies an important paper "On a Determination of the Constant of Nutation from the Observations in North Polar Distance of Polaris, Cephei 51, and δ Ursæ Minoris made with the

Transit Circle of the Royal Observatory, Greenwich, 1851–1865." The result is as follows:—

Supposing δp, δc, and δm to be the respective errors in the assumed values ($0''\cdot00$, $+0''\cdot08$, and $-0''\cdot03$, respectively) of the proper motion of Polaris, 51 Cephei, and δ Ursæ Minoris, in North Polar distance, the expression for the Nutation Constant comes out—

$$9''\cdot133 + 3\cdot05\,\delta p + 0\cdot44\,\delta m - 0\cdot90\,\delta c.$$

Mr. Proctor points out that no notice is taken in the Nautical Almanacs of certain partial Lunar Eclipses—those, *viz.*, in which the moon passes within the earth's penumbra, but not within the umbra. This seems to be a defect, because penumbral passages have now an evident value on account of the application of spectroscopic analysis. There seems to be something defective also in the theory of eclipses as usually presented in works on astronomy, in which no notice whatever is taken of penumbral lunar eclipses. Mr. Proctor gives the elements of a penumbral eclipse of the moon which took place on the morning of September 2nd of the present year.

4. BOTANY, VEGETABLE PHYSIOLOGY, AND MORPHOLOGY.

AMERICA.—*Diatoms, &c., in Hot Springs.*—Mr. A. M. Edwards draws attention in a recent paper to the occurrence of Diatomaceæ belonging to the genera *Orthosira*, *Fragillaria*, and *Cocconema*, together with the hairs of insects, in some fine sandy deposit obtained from a Geyser. Dr. Lauder Lindsay enumerates seven genera of Confervæ and Diatomaceæ from the Geysers of Iceland; and observes that the abundance of Diatoms in the thermal waters of Central and Southern Europe warrants us in expecting large additions to the Icelandic Flora from this source alone. Dr. Cohn has described Oscillatoriæ from hot springs containing sulphates, and ascribes the elimination of sulphuretted hydrogen to the action of these organisms. Mr. Edwards, in the paper above referred to, suggests the importance of an examination of the hot sulphureous springs of California for these organisms and for Diatomaceæ. It would, he remarks, be exceedingly interesting to ascertain by comparison of specimens from sulphureous and neighbouring freshwater springs, what modifying effect the thermal conditions have had on the form of the various species. This is a most important method of inquiry, and one which must be fully followed up; for, by its means, we may hope ultimately to arrive at a definite knowledge of the exact relations of living *forms* to the *conditions* of their existence.

Flora of Carolina.—Dr. Curtis has lately issued an important and neatly printed catalogue relating to this subject. Its greatest interest is in the Cryptogamic part, which occupies considerably more than half of the volume. The Flowering plants enumerated are 1873, the Flowerless 2924, of which 2392 are *Fungi;* that is, of the order to which Mr. Curtis has devoted the greater part of his scientific life. Acknowledgments are made to Mr. Sullivant for assistance in arranging the list of Musci and Hepaticæ, and to Professor Tuckerman in that of the Lichenes. This assistance, it would appear, was rendered several years ago, as the arrangement does not in all respects represent Professor Tuckerman's later views. The catalogue is undoubtedly by far the most extensive list of plants ever published in North America; and from the central position of North Carolina in the line of the Atlantic States, and from its including the most developed portion of the Alleghanies, it is very important to botanists in the illustration of geographical distribution and range of species. As regards the *Fungi*, that State may be supposed to contain all the species of the Atlantic States. It is much to be wished that Dr. Curtis would now seriously devote himself to the elaboration of a manual of the *Fungi* of the United States; otherwise, a vast amount of knowledge of these obscure plants may be one of these days lost to the world, and a great want long remain unsupplied.

ENGLAND.—*Professorship of Botany at Oxford.*—The professorship which became vacant by the death of Dr. Daubeny has at length been filled up by the election of Mr. M. A. Lawson, to whom we are indebted for the following account of the *Flora of the Isle of Skye:*—"During the last month I spent a fortnight in this island in investigating its Flora. I had for companions Professor Oliver and Mr. Fox of Great Bardfield, and with their assistance I have drawn up a list of all the plants we found in our various excursions. This list contains 389 species, including the Ferns, Equisetaceæ, and Lycopodiaceæ. Of this number 51 species are new to sub-province 33 in Mr. Watson's Supplement to his 'Cybele Britannica,' 31 are new to his sub-province 32, 120 are new to his sub-province 38, while 51 species are recorded from his sub-province 38, which we did not find in Skye. I propose here to mention only those plants which are in common use by the inhabitants.

First, those which are used for medicinal purposes:—

Achillæa millefolium is a supposed specific for jaundice.

Gentiana campestris and *Menyanthus trifoliata* are extensively collected, and taken as tonics.

Mercurialis perennis, it is said, is largely used for a purgative. Many species of seaweed also are used variously; sometimes simply boiled into a pulp it forms a poultice, at other times it is steeped in whisky and the mixture drunk, in which condition it is considered a universal specific, and the people view it in the same light that the rustics in England view Holloway's pills; and accordingly they take it freely.

"Secondly, those plants which are used in the arts:—

"*Potentilla tormentilla* is often used for tanning nets, instead of bark. The flowers of the *common gorse* are in common use as a dye; but the most important of all to the islanders is the *common ling;* of this they make the roofs of their houses, and bind them together by ropes made of the same material; while their beds and floors are frequently formed of the same plants. The only plants generally cultivated are oats and potatoes. Barley is sometimes grown in more sheltered spots; but the oats, and especially the potatoes, are what the islanders depend upon. Each family has its oat ground and potato patch, and upon the produce of these patches and a barrel of herrings they chiefly subsist. For the manuring of their patches, they use seaweed, which they gather from the shores of the lochs; but besides this they use the roofs and floors of their huts. A man about to marry seeks out a level piece of ground, pares the grass off it, and round this clearing heaps up stones, which are left either loose or cemented with mud; on the top of this half wall, half heap, he stretches a skeleton roof, and covers it with heather to the thickness of a foot or more; and to make this quite secure he binds it together with a network of ropes made from the ling; a large flat stone is placed in the middle of the hut, and a peat fire lighted. There are two apertures; the door, and a hole in one corner of the roof for the chickens to enter in at. This done all is completed, and the man brings in his wife, cow, goat, pig, dog, and cat, and commences the manufacture of a patent manure for their oat and potato patches. The roof, impregnated with smoke, is taken off one year and given to the oats, while the floor is dug up the next and given to the potatoes. This, strange as it may sound to your English ears, is by no means uncommon, especially in the north-eastern part of the island. Among the more interesting plants we found were the following:—*Ribes spicatum*, Robs., abundant on the rocks about Uig and Dunngan Head. *Chrysanthemum segetum*, which fills every patch of cultivated ground. *Mimulus luteus*, which has established itself in many parts of the island, covering a considerable extent of ground, and spreading rapidly both by seed and runners. *Listera cordata*, growing in dense woods about Ryle Akin. *Eriocaulon septangulari*, which is not confined to one loch at Sligachan, as we were told, and as is generally supposed, but which grows abundantly in many of the lochs in the neighbourhood."

Blights and Cholera.—The Rev. M. J. Berkeley thus replies in the 'Gardener's Chronicle' to a number of questions recently put to him by Dr. Gavin Mibroy on behalf of the Epidemiological Society. He remarks, "I do not believe in Hallier's views of the connection of cholera with parasites on rice. I am taking great pains to ascertain what are the rice parasites. I believe Hallier's notions to be entirely theoretical. That some cutaneous disorders arise from fungi is pretty evident; but there is nothing to show that fever or other infectious or contagious diseases arise from the same cause. It was supposed that diphtheria depended on a fungus, but I have examined diphtheritic membranes in which there was no fungus." In reference to the mode of entrance of the parasite fungus, Mr. Berkeley writes, "In the bunt the whole process is traceable, the parasite obtains admission from without, and the spawn traverses the young plant. In plants impregnated by myself, I have seen the stem as well as the grain affected; but I never saw this in the fields. The potato murrain, again, is distinctly traceable in affected tubers, the threads seeming to have a power of decomposing the cell walls, so as to gain admission to the tissues very deeply. In some cases the effect of the presence of the parasite is to produce a hypertrophy of the tissues, in bunt an intensity in the colour of the chlorophyll, or at least such an alteration of colour that a practised eye will at once detect a bunted plant. In many cases, however, I doubt whether the best microscopes will always detect fungus spawn, and such investigations require great caution, as the junctures of the cell walls are very deceptive.

FRANCE.—*Morphology of the Pistil and Ovary.*—M. Van Tieghem has received the French Academy's Bordin prize for 1867 for an essay on this subject. He considers that before examining the distribution of the vascular bundles of the stem and ovary, it is necessary to understand exactly what is meant by the term axis and what by the term appendicular. He then draws this distinction: when the vascular bundles are arranged in such a manner that in transverse section they form a complete circle, or, in other words, surround an ideal line, we have an illustration of an axis; when, on the other hand, the vascular bundles are coordinated in relation to a plane, we have an instance of an appendicular organ. Starting with these definitions, the author proceeds to a minute anatomical analysis of over fifty-five families of plants, selected to illustrate all the combinations of the organs whose morphology he desired to investigate. In order to avoid ambiguity, he has substituted for the term *axile placentation*, the term *angular placentation*: since the former is associated with an hypothesis, while the latter is not. Some of M. Van Tieghem's conclusions will strike botanical readers as singular. For instance, he says that there are double appendicular organs, which spring from the axis under the form of a simple handle, and divide at a certain distance from the point of emergence into simple super-imposed appendices, and which may be said to be inserted one upon the other. Again he explains the adhesion of the ovary by assuming the original coalescence with all the floral whorls which are external to it; a coalescence of the same kind as that which unites the separate carpels into the compound pistil, or the petals and stamens into the monopetalous corolla. The Academy's commissioners do not quite concur in the opinions of M. Van Tieghem, but they think his conclusions worthy of all attention, and regard them as at least extremely ingenious. The memoir extends over 200 pages, and is illustrated by an atlas containing 500 carefully drawn figures, illustrative of the plants examined and of the dissections. As showing how carefully the French conduct their awards of prizes, it may be mentioned that the commissioners repeated several of M. Van Tieghem's dissections, and found his statements absolutely correct.

Antherozoids of Mosses.—M. E. Roze has been studying these. His first investigations led him to express the opinion that these organs are composed of a biciliated filament with two spiral turns, to which a mass of amylaceous granules adhered, but only during their motility. In the spring of this year he ascertained that these granules, instead of being affixed directly to the spiral, are contained in a hyaline plasmic vesicle, which is attached to the filament by a sort of tangential adhesion. Under a power of 1,500 diameters, this vesicle is clearly discerned, both by its spheroidal outline and by the very brisk molecular movements of its contents. It swells in water immediately after the quiescence of the ciliated spiral, then it suddenly bursts, and the amylaceous granules continue in the liquid the lively molecular trepidation which seems normally, in the vesicle, to coincide with the cessation of the ciliary movement. Except as regards the existence of this vesicle, the facts previously indicated by the author are by no means modified. From this new fact it appears that the antherozoids of all classes of Cryptogamia present not only an organ of locomotion, but also a vesicular appendage filled with a plasmic liquid, suspending either non-analyzable grains or amylaceous granules. This fact was foreseen by M. Ad. Brongniart. The author's recent observations were made upon the antherozoids of various genera of Polytrichaceæ (*Atrichum, Pogonatum, Polytrichum*), still contained in their mother cells, and upon the free antherozoids of *Bryum capillare* and *B. pseudo-triquetrum, Mnium hornum* and *Hypnum cupressiforme.*

5. CHEMISTRY.

M. MARTIN has made some experiments upon the preservation of meat by means of ether. He placed in six tin boxes uncooked beef, surrounded by little tufts of cotton wool soaked in sulphuric ether; the boxes were then soldered tight, and exposed to the rays of the sun. Every three months a box was opened. Each piece of meat weighed a kilogramme. At the end of three months there was no alteration either in weight or form. The meat thus preserved does not undergo the putrid fermentation; it is strongly impregnated with ether, and the odour remains after numerous washings with cold water. When cooked the meat possesses a peculiar savour, probably due, M. Martin says, to the formation of a new ether: the fibre is disintegrated. The process is not applicable to the preservation of food, but other animal matters might perhaps be advantageously treated by it.

An ingenious method of testing fatty matters, founded upon the solubility of rosaniline in certain fatty acids, has been devised by M. Jacobsen; it is applicable, among other things, to the examination of cod-liver oil. A little piece of dry rosaniline placed in a sample of perfectly neutral oil, agitated and heated upon the water-bath, remains undissolved, but if placed in a rancid oil, a red tint is rapidly developed. Oleic acid and the other fatty acids dissolve rosaniline in large quantity, and become opaque from the depth of the tint, because oleate of rosaniline is soluble, in all proportions, in oils and other fatty substances. This property enables the presence of fatty acids in oils to be detected. For instance in commerce we have had, for some years, pretended white cod-liver oils, which are only fatty fluids from very young animals, or veritable cod-liver oil which has been agitated with potash, allowed to repose, and filtered. Since the therapeutic effects of cod-liver oil depend essentially upon the amount of free fatty acids which it contains, neither of these white oils can be valuable. Genuine cod-liver oil agitated with a little rosaniline is promptly coloured red in the cold, and if heated upon the sand-bath the colour is very deep, while the bad specimens already referred to remain perfectly uncoloured.

When an oil which is only slightly rancid contains but a small amount of fatty acids, the coloration often does not become sensible at first. In this case it is better to prepare a solution of rosaniline in absolute alcohol, add a few drops of this to the oil to be examined, and heat on the water-bath until all the alcohol has been evaporated. If no fatty acid exist, the rosaniline soon separates and rises to the surface, or when the oil is too thick, rests in suspension as a brown powder. Samples of ordinary oil occurring in commerce have given the following results:—Olive oil and that of sweet almonds remained uncoloured by rosaniline; poppy oil became slightly red; linseed oil became strongly coloured, its natural colour rendering the tint brownish; palm-oil gave a coloration still more intense. It is sufficient to mix olive oil with 5 per cent. of oleic acid to obtain with rosaniline a tint equal to that of raspberry juice.

Mr. E. Smith has given the following very simple test for the presence of a free acid:—Dissolve chloride of silver in just sufficient ammonia to make a clear solution. If a little of the test be added to ordinary spring water, the carbonic acid present in the latter will neutralize the ammonia and precipitate the chloride. This forms a good lecture experiment, the test being a very delicate one.

We hear that a new source of thallium has been discovered in the flue dust obtained from a sulphuric acid works in Holland, where pyrites from Suhrort is burned. This flue dust contains about 1 per cent. of thallium.

Drs. Crum Brown and T. R. Fraser have made an interesting discovery upon the influence of direct chemical addition upon the physiological action of substances. The bodies which they have chosen for examination are the more active of the vegetable alkaloids, and the chemical operation of which they have studied the effect has been the direct addition of iodide of methyl. It was shown by How, that when iodide of methyl acts upon strychnine, brucine, morphia, and other alkaloids, it adds itself to them, and beautiful crystalline bodies are produced, which differ considerably in character from the salts of the alkaloids. The authors have already examined the physiological action of the bodies produced by the addition of iodide of methyl to strychnine, brucine, morphia, thebaia, codein, and nicotine.

It is well known that doses of strychnine, varying from one-twentieth to one-thirtieth of a grain, rapidly produce in rabbits most violent convulsions, and in a few minutes kill the animal; the phenomena produced being due to a localization of its action on the cord. It was found that twelve grains of iodide of methyl-strychnine, when administered (by subcutaneous injection) to rabbits weighing three pounds, produced no effect whatever. Fifteen grains produced symptoms, and twenty killed; but the animal died with symptoms altogether different from those produced by strychnine. In place of violent and spasmodic convulsions and muscular rigidity, the appearances were those of paralysis with complete general flaccidity. The spinal motor nerves were either paralysed or speedily became so; and, instead of the speedy occurrence of muscular rigidity, the muscles remained flaccid, contractile, and alkaline for several hours. In short, by the addition of methyl to strychnine the toxic properties of the latter are diminished about 140 times; and the body produced possesses the physiological action of curare, *viz.* paralysis of the end organs of the motor nerves. Similarly, Brown and Fraser have discovered that the toxic properties of brucine, thebaia, and codeine are immensely diminished by the addition of methyl; and that the bodies produced, instead of being, as all three of these alkaloids are, strongly convulsent, possess, on the contrary, the physiological action of curare. Morphine, as is well known, possesses both soporific and convulsent properties; its toxic action is much diminished by the addition of methyl; its convulsent action is destroyed, but its soporific action remains.

We may appropriately conclude our Chronicles of Chemistry by quoting the following very apposite remarks made by M. Dumas, the secretary of the Academy of Sciences, and one of the leading French chemists:—If every one of us took the fancy of combining with his name that of his great-grandfather, of his grandfather, of his father, and his mother, a singular complication would be found in our registers of births. A lifetime would be passed in learning the names of the persons with whom we were acquainted in our own neighbourhood. As to knowing the names of the inhabitants of a town, that would be an utter impossibility. This is, however, what our *savants* who pursue organic chemistry have to accomplish, so that their language has now arrived at a point of barbarism that cannot be surpassed. Now, would it not be desirable, in all points of view, to adopt a generic word, and to group around such word the names of species in proportion as science extends her conquests? I am particularly interested in organic chemistry, but I declare that time is entirely wanting to me to peruse, while comprehending them, the various memoirs on the science which come under my notice. The complication and insupportable length of the names employed are the sole causes of this.

6. ENGINEERING—CIVIL AND MECHANICAL.

Notwithstanding the partial revival of trade since the last panic, the progress of public works in this country can hardly be said to have kept pace with the times; but it need scarcely be here stated that the only check has been caused by the unwillingness of capitalists to embark in such enterprises. Nevertheless we have, during the past year, witnessed a succession of railway loans being brought out on account of Russian lines, and other foreign loans appear at present to be more in favour than public works at home.

Shipbuilding.—The revival of commerce has naturally led to a demand for ships; but in this branch of industry the Mersey and more northern ports have enjoyed almost a monopoly; the high rate of wages consequent upon the greater cost of living in London, together with the working of the Trades Unions there, having almost succeeded in driving shipbuilding away from the Thames.

Docks and Harbours.—The extension of dock and harbour accommodation is perhaps the best possible sign of the prosperity of any nation, as it naturally indicates a demand for increased facilities for its external trade. Judged from this standard, the great mineral producing districts of South Wales bear testimony to the prosperity of this land; new docks are in course of construction at Newport and Cardiff; a second dock is about to be commenced at Llanelly; and the new harbour works at Pautcaul have recently been completed and opened. At Liverpool the new corn dock, which has been constructed on the site of the old Waterloo Dock, was opened on 4th July. On Friday the 9th June, the River Wear Commissioners opened their new docks, eleven acres in extent, by running in a fine steamer of 2,000 tons burden, and other large vessels were subsequently passed in, shortly after low water, showing what deep-water accommodation would be afforded at high water. At Blyth considerable improvements have been effected in the harbour by dredging operations, which have been going on for some months; the dredgers have now been placed over the bar in the entrance channel, with the view of facilitating the dispatch of vessels at neap tides.

A magnificent hydraulic-lift graving-dock, upon Mr. Edwin Clark's patent, is now under construction for the Indian Government, for the port of Bombay. It is intended principally for docking the East India transport vessels, and the pontoon provided for this purpose covers more than three-quarters of an acre in area. Another smaller dock of the same description is also about to be constructed for a company, who propose its erection at Jamaica, where accommodation of that sort is at present sadly wanted.

The Egyptian Government has recently signed a contract with an English company for the construction of important works in the harbour of Alexandria, comprising a breakwater, a mole, a line of quay, and a dry dock of sufficient dimensions to accommodate the largest class of vessels.

Railways.—The most important works recently undertaken in connection with railway extension in England are certainly those of the Midland Railway, between Bedford and London, which terminate at St. Pancras, close to the King's Cross Terminus of the Great Northern. It will be remembered that until recently the Midland Railway had its approach to the metropolis over the Great Northern line from Hitchin, at which point it was connected with the latter by a branch from Bedford. Starting from Bedford, the new line passes through Luton, St. Alban's, Hendon, and

Kentish Town to the Euston Road, a distance of about fifty miles. Along the last section of about 6¾ miles the line is laid with four sets of rails, by which means the passenger and goods traffic will be kept distinct; and along the whole distance from Bedford sufficient land has been taken up to admit of the same number of rails being laid all the way. It is, however, the immediate entrance to London, and the terminal works, which demand the chief notice. The entrance into the terminus is on a high level, and advantage has been taken of this in the construction of works connected with the coal traffic, which is likely to become a very large source of income to the company. Beneath the viaduct on which the railway runs, use has been made of the space afforded for storeage accommodation, the construction of stabling, &c., and the arches fronting the road have been fitted up as shops for the purpose of letting. In order to join the Metropolitan Railway it has been necessary also to construct a low-level line, which, running partly in cuttings and partly in tunnels, passes under the main line near the terminus, and runs into the Metropolitan at its King's Cross station. This line was opened for traffic on 13th July last, and it is expected that the main line will be opened in the course of October. The terminus consists of one huge span, in the shape of a pointed arch, no less than 240 feet wide, 100 feet high, and 700 feet long, covering altogether rather more than four acres of ground.

The Brecon and Merthyr Railway has at length been opened as far as the town of Merthyr Tydfil, and a junction for minerals and goods traffic has been made with the Taff Vale Railway. The Bala and Dolgelly line has also been formally opened. This line is in continuation of that between Bala and Corwen, and will form the nearest route from Liverpool, Chester, Manchester, &c., to Merionethshire, Carnarvonshire, and part of Cardiganshire.

The great engineering works in connection with the enlargement and improvement of Lime Street station at Liverpool, are being pushed forward. The immense roof, in one span, will stretch across the station to the width of 214 feet, its height will be 75 feet, and length 385 feet.

The Queensferry branch of the North British railway system has recently been opened throughout for passengers.

In India the Bhore Ghaut section of the Great Indian Peninsula Railway was reopened in sound and perfect condition on the 30th June.

The Eastern and Western sections of the Pacific Railway in America have been brought within 900 miles of each other, and it is expected that the whole will be opened for through traffic from New York to San Francisco on the 4th July next.

On the continent we have to note the opening of the Voltri and Savona section of the Genoa and Nice Railway, which has been carried almost entirely through rock; there being in the $18\frac{1}{8}$ miles of its course no less than thirty-nine tunnels, the longest of which is 3,920 feet. The railway from Foggia to Candela was also opened to the public on 4th May last.

Bridges, &c.—The viaduct which has for some time past been in course of construction over the Solway Firth, as a part of the Solway Junction Railway, was practically completed on the 27th June. The bridge over the Dee at Kirkcudbright was formally opened on the 9th July.

A light roadway bridge, chiefly for foot-passengers and for the accommodation of visitors, is now being erected just below the Niagara Falls, the clear distance between the centres of towers being 1,268 feet. A commencement has also been made for the construction of a trussed girder-bridge, with three spans, across the Mississippi river at St. Louis, where it is about 1,500 feet wide.

The new suspension-bridge across the Moldau, at Prague, was formally opened in person by the Emperor Franz Joseph, on 21st June. The length between abutments is 820 feet, which is divided into one centre span and two half-spans.

The Mont Cenis Tunnel had, up to 21st August last, been driven 8,647 mètres, leaving 3,573 mètres yet to be completed, and it is thought that the tunnel will certainly be opened in 1870.

The subway under the Chicago river, which is now more than half completed, points to a method of crossing rivers with an extensive navigation hitherto but little adopted, but the advantages of which are gradually becoming better appreciated. This tunnel, which is an experimental one, will connect the east and west sides of Washington Street; and should it be found successful, the bridge communication between the main streets in Chicago will gradually be superseded by this form of crossing. The drift under the river Indus at Attock, in the East Indies, was completed in June last, and it has now been determined to complete the tunnel as a means of communication across the river at that point.

Water Supply, Drainage, &c.—The works for providing an additional supply of water for St. Andrew's were formally opened on 5th June. The supply now obtained will, it is expected, be more than sufficient to meet the wants of the city for fifty years to come. The new waterworks at Paisley are making good progress, and it is expected that the Rowbank water will be flowing to Paisley before the end of September.

The first instalment of the drainage works at Douglas, Isle of Man, has been finished, consisting of a main intercepting sewer running along the shore, and an outfall sewer emptying itself into the bay.

Telegraphs.—The cable for the Anglo-Mediterranean Telegraph Company is expected to be laid by the middle of September. As soon as this portion is completed, the Company intends to commence the construction of the Anglo-Indian line.

A concession for the privilege of laying a telegraphic cable between France and America was, on 6th July last, adjudicated to Baron Emile d'Erlanger and Mr. Julius Reuter, for twenty years, by the French Government. The order for the cable has already been given to the Telegraph Construction and Maintenance Company, who are advertising for coals for the 'Great Eastern,' which is to be brought into requisition for laying the cable.

Miscellaneous.—Amongst miscellaneous metropolitan improvements may be noted the opening of the first portion of the Holborn Valley works, on 25th June; the rapid approach towards completion of the great central Metropolitan Meat Market at Smithfield; and the acceptance of a tender for the extension of the Thames Embankment from the eastern boundary of the Temple precincts to the west abutment of Blackfriars Bridge.

On 30th July the foundation stone was laid of a lighthouse to be erected on Scurdyness, near Montrose. The height of the tower will be 100 feet, and its diameter 23 ft. 2 in. at the base, and 15 ft. 10 in. at the top.

The Havre Maritime Exhibition, which opened in June last, and was originally intended for the display of objects of special interest to the naval architect, marine engineer, or shipowner, turned out to be in no great degree different from other exhibitions in the miscellaneous character of its exhibits. Coming, however, so soon after the great Paris Exhibition of last year, the show at Havre indicated no distinctive progress either in invention or manufacture.

Mechanical.—Perhaps the most important branch of mechanical engineering at the present day, is that devoted to the construction of agricultural implements, which are now being largely exported to the continent, Egypt, and India. Amongst recent improvements in other branches may be briefly noticed Messrs. Deas and Rapier's switch-boxes and indicators, which exhibit a full danger-signal for the least opening of the switches. A mowing-machine, by Mr. G. M. Gerrard, presents several new features of improvement, which space, however, will not allow of being further noticed here. A steam road-hammer has recently been patented by Messrs. Gore and Green, which is intended to supersede rollers for the purpose of consolidating road surfaces. A new rock-boring machine, by Captain Penrice, by the use of which the employment of powder is obviated; it attacks the whole gallery at once, and operating by means of cutters with bevelled edges, it acts in such a way as to disintegrate the rock by a series of blows. A locomotive cottonpress, by Messrs. Appleby, Brothers, is likely to supply a want long felt, and will no doubt be fully appreciated, as soon as known, in all cotton-growing districts.

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7. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

THE volume of the Palæontographical Society's publication for 1867 has been issued during the quarter. It contains portions of five memoirs, namely: (1) the first part of Mr. Binney's monograph of the structure of Fossil Plants found in the Carboniferous strata, including a description of the genus *Calamodendron*, being the plant of which we have casts of the pith in the well-known Calamites. (2) The second part of the Liassic portion of Dr. Duncan's supplement to the original monograph of the Fossil Corals, containing the conclusion of the description of Corals from the zones of *Ammonites angulatus*, *A. planorbis*, &c.; and descriptions of those from the Lower and Middle Lias. (3) The second instalment of Dr. Wright's monograph of the Cretaceous Echinodermata. (4) The Cephalaspidæ of the Old Red Sandstone, by Mr. Lankester. And (5) another portion of the apparently interminable description of *Felis spelæa*, by Messrs. Boyd Dawkins and W. A. Sanford.

Mr. Busk's long-expected memoir on the Elephant remains of the Zebbug cavern, in the Island of Malta, has at length been published in the 'Transactions of the Zoological Society.'* The examination of these remains was commenced by the late Dr. Falconer, whose notes Mr. Busk has included in his memoir. Dr. Falconer had in conversations, and in speeches made at the meetings of the Geological Society, aroused great interest in this cave by stating that it had yielded abundant evidence of the previous existence of a pigmy elephant on the Island of Malta, which he proposed to call *Elephas Melitensis*; but, stranger still, Mr. Busk has discovered in the collection under description remains of a second and still smaller species, which he proposes to name *E. Falconeri*. The former of these is computed to have been about 4 ft. 3 in. to 4 ft. 6 in. in height, and the latter not to have exceeded from 2½ to 3 feet. When we remember that an average full-grown Indian or African elephant has a height of about 9 feet, the diminutive size of these fossil forms is something remarkable.

An exhaustive account of the Volcanoes of the Hawaiian Islands, with a history of their various eruptions, has just been published by Mr. W. T. Brigham in the Memoirs of the Boston Society of

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* Vol vi., part 5.

Natural History.* The frightful destruction caused by the eruptions of Mauna Lòa has on several occasions drawn public attention to this group of volcanoes, so that Mr. Brigham's admirable essay possesses a more than geological interest. Two conclusions of a purely scientific nature are, however, especially worthy of record. The author observed that although the craters of the group occur along a line supposed to be a line of fissure, as in other regions, yet that the major axes, or directions, of the craters were parallel to one another at an angle of 26° from the trend of the group; in other words, the supposed volcanic fissure trends N. 64° W., the major axes being N. and S. On following out the idea suggested by this circumstance the author found that the major axes of craters are always at right angles to the mountain chains in which they are situated. Thus he was led to reconsider the whole theory of volcanoes, and his conclusion is that the theory of an unequally contracting crust, causing certain portions to fall below the general level, opening rents at the boundaries, and forcing up molten matter to the surface, seems to satisfy the known condition of volcanoes better than any other.

Mr. R. D. Darbishire has published in the memoirs of the Literary and Philosophical Society of Manchester † a paper on some superficial deposits at Great Orme's Head, in which he describes "Pholas-burrows" as still discernible in the limestone rock at various heights up to 570 feet, and the legitimate conclusion which he draws is that the district has been under water since it was covered with ice. He has also discovered similar "Pholas-holes" near Buxton at a height of about 1,400 feet. If these holes are really the borings of *Pholades*, the fact is of the greatest interest; and the photographs of the specimens, by which the paper is illustrated, certainly lend great probability to the author's inference.

In a paper read before the Royal Geological Society of Ireland last November, "On Parts of South Devon and Cornwall, with Remarks on the true Relations of the Old Red Sandstone to the Devonian Formation," Mr. Jukes comes to the conclusion that the former "lies wholly below the Devonian slates and limestones, which contain marine fossils, both in Munster and Devon." As to the Devonian formation and the Carboniferous Limestone, he does not wish to "dogmatize," but it is evidently his belief that they are contemporaneous. We should mention that while Mr. Jukes's geological statements are always read with respect and attention, his onslaughts on Palæontology weaken the force of what would otherwise be regarded as a resonably good case, as it makes one suspect that the difference between his views and those of other geologists must there also be attributed to the want of power of observation.

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* Vol. i., part 3.

† 3rd series, vol. iv.

The Tyneside Naturalists' Field Club has long been known as one of the foremost in the country; and in having encouraged the working-out of the natural history of the district over which its labours extend, it is decidedly in advance of any other local society in Great Britain. The last volume of the new series of its publication * is entirely occupied with "A New Flora of Northumberland and Durham," of a very comprehensive character. We must leave the Botany to other judges, and shall merely mention that the preliminary essay on the Geology of the district, by Mr. George Tate, is remarkably good, although it contains reference to a division of the Carboniferous Limestone (*Tuedian*) which is not usually recognized. Perhaps Mr. Jukes would call it Carboniferous Slate. Mr. Baker's observations on the influence of the subjacent rocks on plant-distribution are extremly good, and we are glad to notice that Thurmann's division of rocks into Dysgeogenous (or bad producers of soil) and Eugeogenous (or good producers of soil) has been adopted by the author.

In the 'Annals and Magazine of Natural History,' for July and August, Professor W. King and Dr. Carpenter have returned to their old battle-ground, the structure of *Spirifer cuspidatus*. The former author regards the so-called "perforated" and "imperforate" forms as belonging to one and the same species, the absence of perforations being the result of metamorphism; while Dr. Carpenter avers that the imperforate form has a continuous shell-structure, which would not be the case had it once been perforated and the tubes subsequently obliterated by metamorphism.

In the July number of the same Magazine Dr. Nicholson describes a new genus of Graptolites (*Helicograpsus*); and Professor Rupert Jones and Dr. Holl publish another instalment of their "Notes on the Palæozoic Bivalved Entomostraca," including descriptions of Lower Silurian species from the Chair of Kildare.

The Cretaceous deposits of Spain have more importance than their representatives in other countries, as they yield the chief supplies of coal in the eastern part of the peninsula. Of these coal-bearing strata those of Utrillas, near Montalban, occupy the first rank, and the memoir on their Fossils, "Description des fossiles du Néocomien Supérieur de Utrillas et ses Environs (Province de Teruel)," by Messrs. de Verneuil and de Lorière will be of great importance in future searches for combustible minerals in that country, as all the Spanish productive coal-beds of Secondary age are shown to correspond in date with those of Utrillas. It is also worthy of note that the fossils include several species of *Vicarya*,—a genus which was first described from the Eocene beds of India, where it is represented by only one species, and of which, until now, only a second representative was known, namely, from the Miocene beds of Java.

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* 'Natural History Transactions of Northumberland and Durham,' vol ix.

The Report of the Dundee Meeting of the British Association has been issued during the past quarter; but we need only state that it contains the third Report of the Committee for exploring Kent's Cavern, Devonshire; and Mr. Henry Woodward's third Report on the Structure and Classification of the Fossil Crustacea.

Professor Heer's great work on the Miocene Flora of the Arctic regions* has been published within the last few months. A synopsis of its contents would be identical with the account of his paper read before the Royal Dublin Society, which we gave in a former Chronicle.

The absolute duration of geological time is a question which is now exciting the attention of physicists and geologists, owing chiefly to Mr. Croll's numerous papers bearing more or less directly on the subject. In the May and August numbers of the 'Philosophical Magazine' are two instalments of a paper by him "On Geological Time, and the probable Date of the Glacial and the Upper Miocene Period;" but we shall reserve our record of his conclusions until its completion. From another point of view Mr. Geikie has computed, in a paper in the 'Geological Magazine' for June, that "such a continent as Europe will, at the present rate of subaërial waste, be worn away in about 4,000,000 years."

The only other paper in the 'Geological Magazine' for the quarter which we have space to notice is one by Mr. Davidson, "On the Earliest Forms of Brachiopoda discovered in Britain." In the lowest beds of the Lower Cambrian (Sedgwick) there are no Brachiopods; in the Harlech Group above is a *Lingulella*, which passes up into the overlying Menevian Group, or Lower Lingula Flags, and is associated probably in the former, and certainly in the latter, with a *Discina* and an *Obolella*. The genus *Orthis* also makes its first appearance in the Menevian beds. In the Middle Lingula Flags we have *Lingulella*, *Lingula*, and *Kutorgina* (*Obolella*); and in the upper beds, in addition to a species of each of those genera, there occurs another *Orthis*. In the upper division of the Primordial zone (Tremadoc slates) the same genera occur, with the exception of *Orthis*, which, however, becomes abundant in the Lower Llandeilo. This paper is an interesting contribution to the facts relative to the first appearance of life.

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* Flora fossilis arctica. Die fossile Flora der Polarländer; von Dr. Oswald Heer. Mit einem Anhang über versteinerte Hölzer der arctischen Zone, von Dr. Carl Cromer.

PROCEEDINGS OF THE GEOLOGICAL SOCIETY.

A large proportion of the Society's Proceedings during the last Session has been published in the August number of the 'Quarterly Journal;' but we shall content ourselves with a notice of a few of the papers of more general interest.

In a paper "On the Speeton Clay," the author, Mr. J. W. Judd, has very ably sustained the reputation which he gained by his first communication to the Society "On the Strata which form the Base of the Lincolnshire Wolds." Under the name "Speeton Clay" he includes all the beds of clay exposed in Filey Bay intermediate between the Hunstanton Limestone and the Coralline Oolite, a series of deposits of very great thickness and importance. He regards it as certainly *not* the equivalent of the Gault, either as a whole or in part, no portion of it being referable, in his opinion, to that formation. He divides it into seven stages, well marked lithologically, and even better defined palæontologically. They are:—(1) the Upper Neocomian, having its equivalent in the Lower Greensand of the south of England; (2) the Middle Neocomian, of which the Tealby series of Lincolnshire is the equivalent; (3) the Lower Neocomian, now recognized for the first time in England; (4) the Portlandian, agreeing, however, much more closely with some of the continental representatives of that formation than with the limestone and sand of Portland; and (5), (6), and (7) the Upper, Middle, and Lower Kimmeridge. This classification is a very great advance on our previous knowledge, and is the more welcome as the reference of the upper portion of the Speeton Clay to the Gault, made many years ago by Professor Phillips, has too frequently been regarded as a proved fact instead of, what it really was, merely a suggestion,—no doubt of great value in the then imperfect state of our knowledge.

The Duke of Argyll, whose ability as a scientific critic is of the highest rank, has a paper "On the Physical Geography of Argyllshire in connection with its Geological Structure;" but the title is scarcely an accurate index of its contents. In point of fact it is a criticism on the subaërial denudation theories, as set forth in Mr. Geikie's work upon 'The Scenery of Scotland viewed in connection with its Physical Geology.' It is impossible in a few words to review an elaborate criticism, the value and force of which depend in a great measure on its being thorough and elaborate; we must therefore content ourselves with stating that the author's opinions are those of the older school of geologists,—that subterranean movements have had the greater influence in producing the most prominent features of Highland scenery, instead of the very minute effect which the "Erosionists" ascribe to them.

In a paper "On the Affinities and Probable Habits of the

Extinct Australian Marsupial, *Thylacoleo carnifex*, Owen," Mr. W. H. Flower combats Professor Owen's reference of that animal to the carnivorous type of Marsupials, chiefly because in it the canines are very small and the anterior incisors are largely developed, as in the Rat-kangaroos and other phytophagous Marsupials, while in the true carnivores, whether implacental or placental, the canines are very large and the anterior incisors very small. Anatomists differ in their opinion as to the overwhelming force of this argument, and many refer, on the one hand, to the molar teeth and other organs of *Thylacoleo* as differing considerably from those of any true herbivore; and on the other, to the flesh-eating Shrews and Hedgehogs, in which the development of the anterior incisors does take place at the expense of the lateral incisors and the canines.

Mr. Hull has two papers of great merit on cognate subjects. In the first he shows that the south-easterly attenuation of the Carboniferous *sedimentary* strata of the North of England, which he showed to occur in a former paper, is made the more evident by his recent investigations further north than he had previously surveyed, as in that direction those deposits continue to expand at the expense of the *calcareous* portion of the series (Mountain limestone), which he had previously shown to attain a prodigious development in the south-east.

In the second paper, "On the Relative Ages of the leading Physical Features and Lines of Elevation of the Carboniferous District of Lancashire and Yorkshire," he shows that the main lines of disturbance may be assigned to three distinct periods, namely, First and earliest, the Pendle system, having an E.N.E. direction, and marking the close of the Carboniferous period. Secondly, the Pennine system, having a direction nearly north and south, and belonging to the close of the Permian period. And thirdly, the most recent of all, the lines of fracture running N.N.W., which were formed at the close of the Jurassic period. The periods of denudation in this district he refers to seven distinct epochs, beginning with the commencement of the Permian period and ending with that which ensued at the close of the Glacial epoch.

8. METALLURGY AND MINING.

In 'The Mineral Statistics of the United Kingdom,' just issued from the Mining Record Office, we find the following returns of our Mineral produce for 1867 :—

			Value.		
	Tons.	Cwt.	£	s.	d.
Tin ore, from 117 mines	13,649	0 ..	694,734	0	0
Copper ore, from 164 mines ..	158,544	0 ..	699,693	19	0
Lead ore, from 330 mines ..	93,450	6 ..	1,158,272	0	0
Zinc ore	13,488	17 ..	41,240	11	11

	Tons.	Cwt.	Value. £	s.	d.
Iron-pyrites	116,889	7 ..	67,454	5	10
Gold quartz	3,241	4			
Arsenic	1,255	5 ..	2,112	10	6
Ochres and gossans	5,480	0 ..	5,807	10	0
Nickel	1	17 ..	14	12	5
Wolfram	10	10 ..	62	0	0
Manganese	807	18 ..	1,615	16	0
IRON ORE	9,965,293	0 ..	2,936,322	11	4
COAL	104,501,249	0 ..	26,125,312	0	0
Barytes	7,500	0 ..	4,875	0	0
Clays	1,125,924	0 ..	375,900	0	0
Salt	993,880	0 ..	223,010	14	0
Coprolites	37,000	0 ..	45,500	0	0

The only point calling for attention appears to be the continued increase in the production of coal, in the face of the depression which has been continued for some time in every description of manufacture. Metalliferous mining does not rally from the low state to which it has fallen. By a desperate effort the production of ores is maintained with tolerable steadiness, but the mines which are working to a profit are exceedingly few.

The metals produced from the ores raised from the mines of Great Britain and Ireland were as follows:—

		Value.
Tin	8,700 tons ..	£799,203
Copper ..	10,233 " ..	831,761
Lead	68,437 " ..	1,337,509
Zinc	3,750 " ..	79,693
Gold	1,520 ounces ..	5,320
Iron	4,773,771 tons ..	11,934,427
Silver ..	804,024 ounces ..	215,400

Of Foreign copper ores we imported 73,957 tons, and of regulus 28,825 tons; these, smelted at Swansea and Liverpool, produced 19,567 tons of copper.

In connection with these statistics of our Mineral produce, we find in the 'Moniteur des Intérêts Matériels' the following estimate of the production of copper in the world at large in 1866:—

	Tons.		Tons.
Chili and Peru	34,357	Turkey	2,000
United States	14,485	Belgium	1,825
England	11,153	Spain	975
Russia	5,600	Italy, Coast of Africa, and Mediterranean	850
Australia	4,250	Saxony	370
Austria	3,775	Hesse and Nassau	355
Prussia	3,500	Hanover	200
Sweden and Norway	2,850	Portugal	125
China and Japan	2,700	Sundry places	500
France	2,500		

Within a short period it appears probable that there will be a revival of Mining in Africa. Reports are received giving a most favourable account of some of the copper-producing districts of South Africa. There is no doubt that an extensive coal-field exists in Natal, and an experienced English geologist is to be sent to the colony to report on it. The gold-fields on the Limpopo river are exciting much attention.

Mr. Bauerman and Dr. Le Neve Foster, who went to Egypt to explore the mountain-range of Sinai and some part of the coasts of the Red Sea, for the Viceroy of Egypt, have returned to England. Their report will contain much valuable information. The latter gentleman has started for Venezuela—he heads an expedition to explore the new gold-fields of the Orinoco.

We have before us a return of the production of coal in 1867 from the Sarrebruck coal-basin:—

3,171,125 metrical tons (of 2,204 lbs. 10 ounces) of coal were raised, which was a slight advance upon the production of 1866. Of this quantity France took 971,695 tons, Prussia 453,685, the Zollverein 641,754 tons, and Switzerland 108,659 tons.

The coal-production of the Calais coal-field is stated to have been nearly 2,000,000 tons last year, this quantity having been obtained from seventeen collieries. Of these five only are of any importance: Lens produced 400,000 tons, and Counieres, Nœux, Grenay, and Dourgis about 100,000 tons each annually. The price of this coal at the pits is maintained at from 15*s.* to 17*s.* the ton. It is mainly used to supply seventy-six sugar-mills, twenty-two distilleries, and eighteen flax and silk mills.

Within the bounds of the great commercial union of Germany,—the Zollverein,—there are at the present time no less than 198 mines producing the precious metals. The gold and silver ore weighed during the year amounted to 641,000 cwt. In Saxony alone there were 176 mines, producing 598,546 cwt. of silver ore. The mines of Prussia gave 30,090 cwt. of ore, those of Bavaria 2,850 cwt., and those of Anhault 17,515 cwt. The auriferous ores extracted were valued at 21,268*l.* The argentiferous ores were far more abundant; they were smelted at thirteen furnaces, and yielded 157,084 lbs. of silver.

Coal in Russia.—It is to be regretted that journals professing to chronicle the progress of science, should allow themselves to be made the medium for conveying to the public, as established facts, the speculations of adventurers. We find in 'Les Mondes' a paragraph to this effect—"Contrary to the previsions of that celebrated geologist Murchison, the country is rich in deposits of coal." It then gives a list of places where, it is implied, coal exists in abundance. Now every one of the places named have been long known to contain coal, and in some of the districts there is a wide spread of coal-measures; but the coal is insignificant in quantity, and many of the carboniferous measures are destitute of true coal. This statement, so hastily copied by 'Les Mondes,' has its origin in the circumstance that the little coal-field of Donetz has been brought forward as one of promise; and General Helmersen has proved the extension of the coal-field on the western flanks of the Ural considerably to the south. A company has been formed, and two colliery viewers from our Midland Counties have been engaged to visit the district and to report upon the prospects. In a subsequent number of 'Les Mondes' a letter from Sir Roderick Murchison directs attention to his work on the 'Geology of Russia,' in which the coal-fields of Russia are fully described, and their value very satisfactorily stated. This is followed by the poor excuse that "l'article erroné" was taken from an English journal. The editor of a scientific periodical should be taught that he ought not to rely on newspaper announcements which have not some mark of authenticity.

The Siemens-Martin's process for the manufacture of steel is exciting much attention at the present time. During the last few years experiments have been made by Martin to supplant crucible steel with reverberatory furnace-steel, and the final success appears to be due to the use of Siemens' furnace and a due adjustment of the proportions of the materials employed. At the works of M. Verdie experiments on a large scale have been for some time going on, with every appearance of success, and similar results are now being obtained at the New Steel Works of Messrs. Samuelson and Co., near the Newport Iron Works, Middlesborough.

The Martin process consists essentially of the fusion together on an open hearth of cast and wrought-iron with rich oxides of iron, in proper proportions and under proper conditions, especially that of temperature, the heat required being about 4,000° Fahr., which could only be obtained by the use of Siemens' furnace.

The apparatus consists of one Siemens' regenerator furnace, one reverberatory furnace, and one heating furnace. The materials employed are Swedish iron, Spiegeleisen, wrought-iron,—specially-prepared Cleveland puddled bars,—in which the phosphorus has been eliminated as far as possible. The material used by M. Verdie is raw iron made from Algerian ores, and iron and steel shavings of the same origin. Ingots of very soft steel are more especially being manufactured at present, but any temper and hardness are said to be completely under command.

The Iron Ores used in the Blast Furnaces of France are principally those of the Boulonnais, in the Pas-de-Calais, and of the Avesnes (Nord). The first-named ores, containing 27 per cent. of iron, are carried by railway to the furnaces of the Pas-de-Calais, and they cost, delivered at Denain, 14*s.* 6*d.* per ton. The second, found near Malplaquet, Fourmies, and Maubeuge, give from 34 to 35 per cent. of iron, and are delivered at Fourmies at 6*s.* 8*d.* per ton. The oolitic ores of the Moselle and those of Champagne are said to yield 38 per cent. of iron, while those of Tournai give but

25 per cent.; these ores cost from 8*s*. to 10*s*. per ton delivered at Denain. Spanish iron-ores sent from Bilboa, yielding 50 per cent. of iron, and costing 1*l*. 4*s*. per ton, are used. Algerian iron-ores, said to give 65 per cent. of iron, are sent to France from Mokta-el-Hadid, and costs 1*l*. 8*s*. 10*d*. a-ton delivered at Dunkerque.

Wolfram steel some years since attracted some attention, and M. Jacob, the patentee of a process for effecting the combination, produced some beautiful examples of cutlery made from steel produced by his process. At Messrs. Cockerell and Co.'s Works in Belgium they are now using 2½ tons of wolfram per month in this manufacture.

Several French engineers have reported more favourably on the strength of iron produced by alloying ordinary pig-iron with tungsten. It is evident that some good experiments, made on a large scale, and under varied circumstances, are required to settle this question.

9. MINERALOGY.

In our Chronicles of last quarter we called attention to a recently-discovered form of silica, described by Vom Rath under the name of *Tridymite*. It now remains to describe the characters of the new mineral, and to point out the interest attaching to its discovery. Hitherto it has been the fashion to recognize two distinct forms of silica: the one, represented by common quartz, having a specific gravity of about 2·6, and crystallizing in the hexagonal system; the other, represented by opal, having a specific gravity of 2·2 or 2·3, and being non-crystalline or amorphous. A relation was thus established between density and form; and on this relation many deductions were based. We now find, however, that a low density does not necessarily connote an amorphous condition; for Vom Rath discovers a species of silica which has a specific gravity of only 2·2 or 2·3, and yet assumes well-defined crystalline forms. These forms, although belonging to the rhombohedral system, are in no wise related to those of ordinary quartz; and hence silica turns out to be dimorphous. Our new mineral occurs in small six-sided tabular crystals, which are usually grouped together in (to use a solecism) twins of threes, or, as the Germans more aptly express it, in *Drillingen*. It is this peculiarity of a three-twinned growth that has suggested the name "Tridymite." Associated with specular iron-ore and acicular hornblende, these crystals bestud the cavities of a volcanic porphyry from the Cerro San Cristobal, near Pachuca, in Mexico. That they are not pseudomorphs of amorphous silica after some hexagonal species, is clearly proved by the property which they possess of double refraction.*

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* 'Poggendorff's Annalen,' No. 3, p. 507; 'Geol. Mag.,' No. 48, p. 281.

In a letter addressed to Professor Leonhard,* Dr. Sandberger notes the discovery of Tridymite in the cavities of a trachyte from Mont Dore les Bains, where it is accompanied by rock crystal. The two dimorphic forms of crystallized silica are thus presented in association.

Everyone must have experienced the difficulty of retaining in mind for any length of time the formulæ of minerals which present a complex constitution, notably those of the compound silicates. To assist in overcoming this difficulty the Rev. B. W. Gibsone suggests the employment of a mnemonic system.† Using consonants to represent the digits, he forms memorial words associated in a fanciful manner with the minerals to which they relate, and then throws the whole into rhyme in order to fix it the better in memory. Some of these rhymes form such frightful jargon that we could not disgrace our pages by transcribing them; but to give our readers a notion of this kind of *memoria technica* we may pick out one or two of the best couplets. Here is one:

"Heat Topaz and its tint will *fade*;
Of *murder* Scapolite's afraid."

Here is another:

"*Never* smoke Meerschaum, or the croup
Will *hurt* Picrosmine's *heart*."

In these examples the memorial words are italicized. Thus, in the first line, the word *fade*, when translated into figures, gives for Topaz the value of the numerical constants in a standard formula. With the exception of students who are cramming to satisfy over-reaching examiners, there are probably few who would be willing to rely upon a system so essentially artificial.

For the third time during the present century the province of Casale, in Piedmont, has been the scene of a shower of meteoric stones. On the 29th of last February, at about 10 a.m., explosions were heard over a considerable area, and small clouds were observed at a moderate height rapidly moving from N.W. to S.E. These phenomena were followed by a fall of stones, witnessed by several labourers, and at one place a peasant's hat was actually struck by a meteoric fragment. Although several stones were seen to fall, only a few pieces were afterwards found. As usual, the stones were coated with a hard black varnish-like crust, and on fracture they presented a lighter colour and a fine texture somewhat resembling that of trachyte. The fall occurred between the villages of Villeneuve and Motta de' Conti. The stones from the latter place were too small for quantitative examination, but those from the former have been carefully analyzed by Dr. Bertolio. Their composition does not differ essentially from that of the meteorites which previously fell in this district on the 17th July, 1840, and on the 2nd February, 1860.*

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* 'Neues Jahrbuch f. Mineralogie,' u.s.w. 1868, Heft IV., p. 406.

† Aide-mémoire for siliceous formulæ. 'Chem. News,' Aug. 21, 1868.

A mass of meteoric iron has been found near Nöbdenitz, in Saxony, and is believed by Dr. Geinitz to be of meteoric origin. In some of its characters it much resembles a metallurgical product, but on analysis no carbon was found, whilst nickel was detected in considerable quantity. It differs, moreover, from terrestrial iron in many of its physical properties. Throughout the mass particles of native copper are disseminated, and from this is produced the green carbonate of copper which is associated with the oxide of iron on the exterior of the meteorite. The following is Dr. Fleck's analysis of the Nöbdenitz iron:†—

Iron	88·125
Copper	9·013
Nickel	1·340
Tin	1·321
Cobalt and Chromium	Traces.
	99·799

Attention has also been directed to a somewhat similar mass of iron found about a year ago at Weissenborn, near Zwickau, in Saxony; but it would seem that its meteoric characters are not fully established.

The gorgeous play of iridescent colours exhibited by certain polished specimens of Labradorite must have attracted the eye of even the least scientific observer. To ascertain the cause of this colour and iridescence, Herr Vogelsang has lately subjected some specimens to microscopic examination. Many sections showed a great number of minute disseminated crystals, which he calls "Microliths." These differ considerably in form and colour, and it would be difficult in all cases to say what they really are. Some, however, appear to be diallage, and others magnetic iron ore. The golden reflections exhibited by some labradorites are supposed to result from the total reflection of light incident upon these microliths; whilst the blue colour characteristic of other specimens is apparently due, not to the embedded crystals, since it is equally displayed in their absence, but to a phenomenon of polarization resulting from the refraction of light from one lamella to another.‡

Dr. Scharff has lately studied the characters of that unsatisfactory species, *Sericite.*§ It occurs abundantly in the schists of certain parts of the Taunus range in Western Germany, but it seems doubtful whether it should take rank as a distinct mineral. The author recognizes two varieties—the one fibrous, with a satiny lustre; and the other lamellar, with a metallic lustre: the latter is of younger formation than the former.

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* Bullettino Meteorologico dell' Osservatorio del R. Collego Carlo Alberti in Moncalieri. 31 March, 30 April, 30 June, 1868.

† 'Neues Jahrbuch.' 1868. Heft IV., p. 461.

‡ 'Archives Néerlandaises,' 1868, III., p. 32.

§ 'Neues Jahrbuch,' Heft III., p. 309.

A new species discovered in the copper veins of Nantoko, in Chile, by Herr Herrmann, has received the name of *Nantokite.** In its pure condition it is a perfectly anhydrous chloride of copper, but by exposure to the action of atmospheric influences it becomes converted into atacamite.

Another new species is to be termed *Helvatane,* from its occurrence in the Alps of Switzerland. It is apparently a felspathic mineral, found in the mica-schist of the Tödi Mountains.†

Two closely-allied minerals have long been known under the names of *Leadhillite* and *Susannite.* They occur together in the old mines of Lead Hills in Lanarkshire, and they possess precisely the same chemical composition,—both being sulphato-carbonates of lead. Leadhillite crystallizes, however, in the rhombic system, whilst Susannite affects hexagonal forms. Dr. Kenngott has lately examined these crystals with care, and believes that the apparently hexagonal forms of Susannite are purely deceptive, arising from the twining together of crystals of Leadhillite, just as the rhombic crystals of Witherite become twinned in pseudo-hexagonal forms.‡

10. PHYSICS.

Light.—Professor H. Morton, of the University of Penna, has devised a very ingenious arrangement for obtaining monochromatic light of considerable intensity. The difficulty which there has hitherto been in producing monochromatic light in great quantity prevents us from demonstrating satisfactorily many points of interest in connection with the composition of light and the theory of vision. Coloured glasses placed in the path of powerful beams of white light are doubly unsatisfactory; they reduce the amount of light enormously, and with few exceptions (*e.g.* red glass coloured with gold) yield a beam of mixed colour. The old experiment, the spirit-lamp with salted wick, is admirable as far as it goes, but yields a very faint light at best. Something far superior to this is furnished by the arrangement of a ring of cotton wick wound on a wire, and supported immediately over and around a large Bunsen burner, the wick being soaked with an aqueous solution of some flame-colouring salt. This plan in effect is suggested in Sir David Brewster's natural magic; but as the Bunsen burner was not then known, a less simple arrangement is described to perform the same office. The drawbacks to this arrangement are: the trouble of adjusting the cotton wicks, the delay in changing to produce a new colour, and the brief duration and, to a certain extent, irregular amount of the effect. After lighting, the burners increase their effect to a certain point, and then soon rapidly diminish in the intensity of their light. When a large number of burners are to be used these difficulties become serious, and Professor Morton has therefore devised the following arrangement, which has proved, on trial, thoroughly efficient:—The burners to be used, varying in number from 5 to 30, in different experiments, are enclosed below in a box with a single large entrance, opposite to which is placed an atomiser, operated either by steam or compressed air. A spray of the colouring solution is thus mixed with the air supplying the burners, and their flames are thus tinged with the greatest ease, certainty, and intensity of effect, the whole action being entirely under control, and capable of being maintained indefinitely, while the change from one colour to another is effected by simply transferring the tube of the atomiser from one solution to another.

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* 'Berg-und hüttenmänn. Zeitung,' XXVII., No. 1, p. 3.

† 'Neues Jahrbuch,' Heft III., p. 348.

‡ Ibid., p. 319.

For experiments demanding diffused light this apparatus is most satisfactory. The author says that five large Bunsen burners, thus arranged, light up the lecture room of the Franklin Institute, which seats about 350 persons.

In certain experiments, however, it is necessary to have monochromatic light of great intensity and concentration. This can be furnished in the case of yellow light, to a certain extent, by substituting in the gas microscope or polariscope a soda-glass rod for the ordinary lime cylinder, and so adjusting its position that the rays from the heated glass should be cut off from the lenses, and only the light of the yellow flame should reach them. We can thus show, upon a screen 5 feet in diameter, the greatly increased number of rings developed by a section of Iceland spar in monochromatic light. With the spectroscope we can also project the sodium line on the screen so as to be well seen by an audience of 500 persons. By afterwards producing the absorption band due to the vapour of the substance, with the aid of a small Bunsen burner and iron spoon with sodium, and again showing the absorption-bands of nitric peroxide and of cochineal, the characteristic phenomena of spectrum analysis may be sufficiently illustrated, without the trouble and expense of the electric light.

A novel arrangement of stereoscope and slide has been brought out by Messrs. Warner and Murray, in which the inventors have taken advantage of an important feature in optics hitherto overlooked by all makers of the stereoscope, *viz.* that while the size of two pictures which can be united stereoscopically is limited in the *horizontal* direction by the fact that their centres must be as nearly as possible opposite the pupils of the eyes; in the *vertical* direction it is only limited by the angle of natural vision, which practically admits of the use of a picture nearly double as high as it can be wide. The aim of the inventors has been so to modify the mode of taking, and the instrument for viewing the stereograms, as to take advantage of this fact. Pictures adapted for the panoramic stereoscope have been taken by Mr. Harding Warner, of Ross, the well-known photographer. When taken from great heights and viewed in this instrument, the patentees state that the pictures represent objects in a better relative proportion to each other than when inspected in the old form of stereoscope. The instruments are manufactured in a variety of forms and of elegant designs, to meet the requirements of the pictures; and the latter are printed by the argento-carbon process, so as to ensure permanency.

M. Civiale has brought before the Société de Photographie some observations upon the employment of sulpho-cyanides in toning and fixing. He stated that in the summer of 1867 he fixed about 700 positive proofs by means of potassium and ammonium sulpho-cyanides. A print, one half of which had been protected from the light, the other unprotected, and which had been exposed for three months, showed only an uniform tint. This, however, only shows that this plan of fixing destroys the sensitiveness to light of the silver compound on the surface of the paper. It speaks nothing for or against the liability of the pictures to fade when exposed to darkness and damp.

Electricity.—Wiedemann and Franz have proved experimentally that the values obtained for the conducting power of metals and alloys, for heat and electricity, are identically the same. The truth of this statement was strikingly illustrated by Dr. Matthiessen in a lecture which he gave at one of the Friday Evening Meetings of the Royal Institution. Bars of gold and silver and some gold-silver alloys were fixed so that one end of all of them was in a hot-water box and the other end in the bulb of a small air-thermometer; the depression in the columns of the liquid in the tubes of the air-thermometers then indicated the relative conducting powers (approximately) of the several bars; and if through the tops of the columns of liquid a line be drawn, such line would form a curve similar to that referred to as obtained for the electric conducting power. That this is true was thus shown:—By the side of this apparatus was placed another of this construction. Into the bulbs of several air-thermometers were fixed wires of the same size and length, and of the same materials as were used in the heat-conducting experiment. One end of each wire was soldered to one thick copper wire, and the other end to another similar wire. These two wires were connected to the poles of a battery. The current would then divide itself, and a portion would pass through every wire proportional to the conducting power of that wire. This current heated the wire and caused the liquid in the tubes connected with the air-thermometers to descend, and the line drawn through the top of the columns was nearly similar to the curve already mentioned, which was formed by the bulbs in which the heat-conducting bars are fixed.

11. ZOOLOGY—ANIMAL MORPHOLOGY AND PHYSIOLOGY.

Morphology.

The Hair of different Races of Men.—M. Pruner-Bey has lately published two series of observations on the microscopic appearances of human hair in the different races. In five plates, he exhibits the forms of transverse sections of the hair in various people, and in many cases at different ages. Several of the more interesting races are represented by a considerable number of individuals, so that the characters of their hair have been established with great precision. Other isolated specimens belong to less known races, but M. Pruner-Bey has thought it advisable to include them for future comparison. He says a few words, especially in the first memoir, with reference to the characters of the hair which are visible to the naked eye. With respect to *colour*, he has established the fact that it is not always *black* in the negress. Besides a red colour, which is very exceptional, he has met with hair of an ashy tint in some cases. Among two hundred specimens of hair from natives of India, only one occurred of a straw colour, and even this might have been of foreign origin. The hair of every race south of the Himalayas is jet black; but in proportion as we ascend into the more elevated regions, a brown colour occurs more and more frequently. The differential characters of the hair of various races are found chiefly in the forms presented by transverse sections; such sections, moreover, afford an opportunity of determining not only the *form*, but also the *size* of the hair, a character which M. Pruner-Bey considers of the greatest importance. Amongst the races whose hair our author has examined are Arabs and Jews, Greeks, Brahmins, and Lithuanians, Fins, Esthonians, Samoyedes, Sicilians, Nigritoes, Australians, Malays, Polynesians, Americans, Chinese, Japanese, and an Ape. The Arian races show a regular oval outline in the transverse section of the hair, whilst the Semitic have a more or less angular outline.

Formation of Coral Reefs.—Dr. Carl Semper, who has resided some years in the Philippines and is a most accomplished naturalist, has brought forward some objections to Darwin's theory that atolls and barrier reefs imply the gradual sinking of a continent or island, whilst coast reefs necessitate an elevation of its shores. Darwin himself, with his true honesty, mentioned some difficulties to the theory, and Dr. Semper now quotes some observations of islands near the Philippines which certainly do not accord with Darwin's theory. He describes a horizontal surface of colossal dimensions, which could not possibly be formed during a depression which a few miles farther north had produced a channel of 70 fathoms in depth. He rather regards the physical influences, especially the internal sea-currents caused by the rain, and the exterior direct and diverted ones, as the cause which have produced in the north of this district atolls, and in the south the coast reefs, simultaneously with an *elevation.* Whilst in the south the deep-going eroding action of the wave-blow or the wash of the sea, has gradually planed away the dense and solid coralline limestone to a nearly horizontal surface, which lies at about the depth to which the sea-wash is capable of acting; in the north, the becks coming down from the mountains conjointly with the wash and currents of the sea, have acted much more strongly upon the soft readily decomposable basalt of the west, than was the case with the limestone of the south, and thus has arisen the apparently incompatible conditions of their respective coral growths.

A natural Hybrid-Barnacle.—Dr. Fritz Müller, of Desterro, in South America, one of the most able of Mr. Darwin's champions, recently directed his attention to the Barnacles occurring on that coast. He found a species of Sea-acorn (*Balanus*) which either attaches itself to, or becomes overgrown by various forms of sponge, and it was observed that the third pair of legs or cirri were equipped with numerous teeth, whence he terms it *B. armatus.* He describes a very remarkable grouping of different species of *Balani* on a rock, according to depth. The sensitiveness of these animals to luminous impressions is not, he says, dependent on the eyes discovered by Leidy. He took a large *Balanus tintinnabulum* living, out of its shell and separated it from the operculum, with which the eyes remained in connection. It lay in a saucer of water, with its cirri half unrolled. As often as the shadow of the hand fell upon it, it rolled up the cirri with a sudden movement. In *B. tintinnabulum* the eyes are very distinct; in *B. armatus* they have not yet been found. The most interesting observation of Dr. Müller's is, however, the existence of a natural hybrid between *B. armatus* and *B. assimilis* which he most minutely describes, and for the existence of which he satisfactorily accounts by the isolation of the respective parents. If, he says, we regard the species of a genus as descendants of a common primitive form, and at the same time, in accordance with the well-known experience of gardeners, regard their various peculiarities as so much better fixed, or so much less variable, the earlier they were acquired, the longer they have been inherited unchanged, it becomes intelligible that, above all, the characters proper to the primitive form persist; and consequently in the crossing of two species, these are more readily transferred to the hybrid than later-acquired peculiarities of the father or mother. From this point of view, Dr. Müller thinks we shall be able to explain many peculiarities of hybrids and, *vice versâ*, perhaps in many cases to trace from the form of the hybrids to the primitive form of the genus; the latter of course only with the greatest care, for the mere fact that the hybrids produced by males of one species with females of another, do not agree with those produced by males of the second species with females of the first, furnishes a proof that other circumstances aid in determining the form of the hybrids.

The Ancestry of Insects.—Dr. Anton Dohrn, of Jena, has lately described a new fossil insect, which he calls *Eugereon Bœckingi*, and which leads him to make some observations on the development of Insects by Natural selection. This Eugereon has characters intermediate between those of the Hemiptera and Neuroptera, and must, says Dr. Dohrn, be regarded as genetically related to the two orders. He does not think, however, that it was the common ancestor of these two groups, for the Neuroptera are found along side of it, but he believes that at a period not much earlier an insect form existed completely intermediate between the Neuroptera and Hemiptera, from which these two orders were differentiated and from which *Eugereon* also was descended, not having become so much modified. Dr. Dohrn then tells us of Haeckel's views (also a Jena professor) whose book we spoke of as most significant when it first appeared. Haeckel says that Insects, Spiders, Centipedes, and Crustacea must have had a common ancestor. The ancestral form of the Crustacea is known, appearing in their development as the Zoëæ. The ancient adult Zoëæ or Zoepoda, as Haeckel calls them, flourished early in the Silurian period according to that author, and it was probably about the Devonian epoch that certain Zoepods were naturally selected for a terrestrial life, developed tracheæ and became *Protracheata*, or progenitors of all the great Tracheiferous group of the articulate-limbed animals; whilst those which remained in the water are the ancestors of the Branchiferous forms called crabs, lobsters, and shrimps. Whether any Protracheatæ still exist is, says Haeckel, doubtful: perhaps the Solifugæ, a strange group of aberrant spiders, and also those insects which have no wings (not through disuse as in many cases, but by their progenitors never developing them) represent amongst to-day's fauna, the Protracheata of the past. Surely it is a pity that the Ray Society did not adopt the suggestion of Professor Newton, at Norwich, to translate so interesting and suggestive a work as that of Haeckel. Rash his speculations may be, but they are of high interest, of much use, and are, at least, noble efforts to grasp truth.

The Glass-Rope Sponge.—The turmoil caused by this beautiful organism among systematic zoologists has taken a new direction. Professor Lovén has described a sponge which he calls *Hyalonema boreale*—placing it thus in the same genus as the Glass-rope; and from the examination of this Boreal species he concludes that every-one else has studied the Japanese sponge upside down. The long glassy fibres are, he says, merely the remains of a long pedicle which was attached to a rock, and on which the mass of the sponge was supported. Dr. Gray protests against this inference. Lovén's species is not a *Hyalonema* at all, but merely a new and interesting pedicellate form, to which there are many similar species. The Rev. A. M. Norman has pointed out several of these, and has shown how their spiculæ differ *inter se*, and from those of Lovén's *Hyalonema boreale*, which is also very different in this respect from the true Japanese *Hyalonema*, or from the reputed Lusitanian species obtained off Portugal.

A Viviparous Echinoderm.—Dr. Ed. Grube describes an Echinoid from the Chinese Seas under the name of *Anochanus*, which actually produces young Echini, like itself, having spines, feet, and even pedicellariæ. These young, though having a general resemblance to the parent, are not quite the same in detail, and must undergo modification with growth. This discovery is of remarkable interest, for it adds one more to the many diverse methods of reproduction known among Echinoderms, and completes the parallel which they present to the Worms. We now know, in both groups, of animals laying eggs which produce embryos developing directly into the adult form; of others which present strange larval conditions which either become completely altered, so as to form the adults, or bud off from their interiors a small mass of living tissue which becomes the adult, leaving the larva to perish. We know, in both groups, of hermaphrodites and of diæcious species, and now we have added a viviparous form of Echinoderm, such as was previously observed in some Nemertian worms. We have yet to discover among the Echinoderms the various modifications of asexual reproduction, by pseudova, fission, or true parthenogenesis; the first two of which methods (especially fission) are so well known among worms.

Parasites of the Sea-cucumbers.—A large division of the Holothuridæ abound in parasites, and oddly enough all these parasites belong to groups in which parasitism is quite a rare exception. In the first place there are fishes which belong to the genus *Fierasfer*, these pass in through the water-tree, or lung, of the animal, they are true parasites, feeding within the Holothuria; then there are several small Crustacea; and thirdly, the Mollusc *Entoconcha*, described by Johann Müller, from Synapta. Dr. Carl Semper describes these in his work on the Echinoderms of the Philippine Islands, and also mentions a new *Entoconcha* which lives in a true sea-cucumber; he also describes parasitic species of *Eulima*; and most interesting of all, a little Lamellibranch which lives on the skin of Synapta, and crawls with a large membranous foot, whilst its shell is so much invested by the mantle as to be completely internal. An addition to the parasites of the Holothuroid Echinoderms was made last year by Mr. Ray Lankester, who discovered a very remarkable Rotifer in great abundance amongst the genitalia of the *Synapta Sarniensis* and *inhærens*, at Guernsey.

PHYSIOLOGY.

New Bodies discovered by the Spectroscope.—We would direct special attention to the very remarkable report of Dr. Thudichum, issued by the Medical Officer of the Privy Council in his last (tenth) Blue Book. Dr. Thudichum sketches in a masterly manner the history of past chemical researches into the functions and products of the human organism. He then describes some of his own researches, apparently carried out within the year, and which have yielded most extraordinary results. New bodies determined by their optical properties are described in this report at the rate of about three a page. This is rather rapid work, and does not leave a very satisfactory impression on the mind. Some most interesting fluorescent products from the chemical decomposition of blood, of albumen, and of urine are described, of which we are most anxious to hear or see more. The spectroscope used by Dr. Thudichum appears to have been an excellent one; but his method of examining only one thickness of a coloured body, has, we fear, led to some misapprehensions as to new bodies. Some of the spectra drawn as new are highly interesting and no doubt indicate new bodies, as, *e.g.*, cruentine and its products; but others are old and well known to all physiologists, though Dr. Thudichum "reports" them as though previously undiscovered. This is a bad sign, and coupled with the hasty appearance of the work does much to diminish the value of what seems otherwise likely to prove a very notable and grand addition to the knowledge of animal chemistry.

Quarterly List of Publications received for Review.

1. The Medical Profession and its Educational and Licensing Bodies. By E. D. Mapother, M.D., Professor of Anatomy and Physiology, Royal College of Surgeons of Ireland. 230 pp. Fcap. 8vo. *Fannin & Co.*
2. Medical Education and Medical Interests. By Isaac Ashe, A.B., M.B. 170 pp. Fcap 8vo. *Fannin & Co.*
3. On Aniline and its Derivatives: a Treatise on the Manufacture of Aniline and Aniline Colours. By M. Reimann, P.D., L.A.M. Edited by William Crookes, F.R.S. 180 pp. 8vo. *Longmans & Co.*
4. Reliquiæ Aquitanicæ. By Edouard Lartêt and Henry Christy. Parts VI. and VII.
5. Guide to the Goldfields of Nova Scotia. By A. Heatherington. 170 pp. Fcap. 8vo. *Trübner & Co.*

PAMPHLETS, PERIODICALS, AND PROCEEDINGS OF SOCIETIES.

Die Darwinsche Theorie und das Migrationsgesetz der Organismen. Von Moritz Wagner, München. *Williams & Norgate.*

Memoirs and Publications of the Geological Survey of India.

Contributions to the History of Development in Animals. I. On Fœtal Circulation. By William Macdonald, M.D., F.R.S.E., Professor of Civil and Natural History, Zoology, and Comparative Anatomy, St. Andrew's.

Report of the First Exhibition of the Aëronautical Society of Great Britain.

Dr. Walter's Doctrines of Life. 28 pp. 8vo.

On the Temperature of the Sea and its Influence on the Climate and Agriculture of the British Isles. By Nicholas Whitley, F.M.S.

Some of the Educational Aspects of State Medicine. By H. W. Rumsey, M.D., &c.

Correspondence on the Subject of Atmospheric Electricity.

On Geological Time. By James Croll.

On Harvesting Corn in Wet Weather. By W. A. Gibbs.
Bell & Daldy.

Hints on House Drainage. By Alfred Carpenter, M.D.

Proceedings of the Essex Institute, Salem, Moss.

Journal and Proceedings of the Academy of Natural Sciences, Philadelphia.

The London Student.

The American Naturalist.

Mineral Statistics of Victoria for 1867.

Journal of the Transactions of the Victoria Institute, or Philosophical Society of Great Britain. Vol. II., No. 7.

The Geological Magazine.

The American Naturalist.

The Westminster Review.

The Public Health.

Proceedings of the Royal Society.

" " Royal Institution.

" " Royal Astronomical Society.

" " Geological Society.

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